"Feel lost without it": The Impact of Mobile Phones on the Market Place Experience

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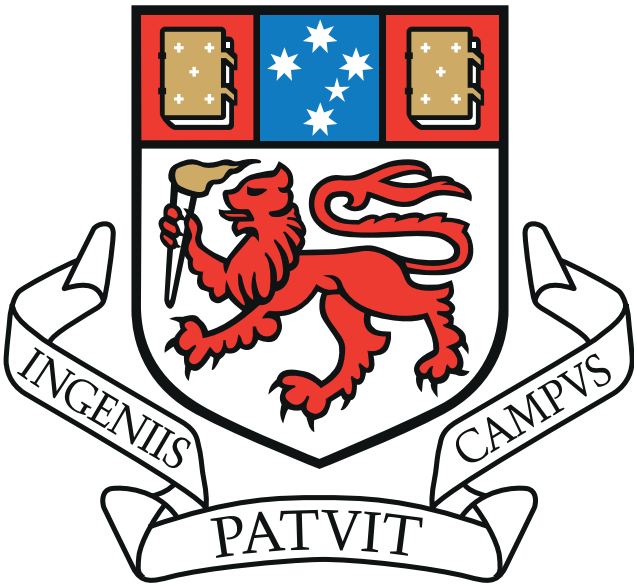

University of Tasmania

October 28, 2016

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Abstract

The research described within this thesis provides an update to and an extension of our understanding of the role of mobile phone technology in those communal public spaces that allow and encourage social interaction amongst its participants. This work explores the current uses of mobile phone technology in outdoor markets, offers insight into the uses of mobile phones by market participants, and creates a framework to aid future researchers. All of which was validated through the design, development, and evaluation of a mobile prototype for outdoor markets.

Mobile phones are now a ubiquitous technology across the world: There are literally billions of mobile phones of many different types, our mobiles are constantly within our reach and where we go they go, and they have woven themselves into our social fabric becoming an integral part of our day-to-day lives. Unfortunately our understanding around their use in public spaces has not kept up with the new ubiquity that mobiles now occupy.

Past research into public space has included work from the "Third Place", urban design, and information grounds but despite offering insight into how people exist and operate in these spaces they fail to account for the impact of computing and mobile technology. This is ignored or relegated to footnotes and future work. The human-computer-interaction fields of ubiquitous computing, awareness, computer-supported-cooperative-work, and urban informatics on the other hand provide information into which tools can be used in public space and how best to develop them. These fields, however lack any insight into how people work in these spaces other than as the entity which will be using the newly introduced artefacts.

Using a methodological approach from urban informatics, mobile tech-

nology in communal public spaces is explored through two phases. A variety of different data collection tools were used and analysed using a grounded approach. Based upon the gaps identified in previous research, this thesis creates an understanding of communal public spaces and the role mobile technology has within them through the example of outdoor markets. This understanding is used as a basis to develop and evaluate mobile application prototypes as well as to create a new conceptual representation of communal public spaces to account for the new insight gained.

This thesis used multiple tools to collect data including surveys, individual and group semi-structured interviews, and prototype evaluation. The prototype evaluation was based on the exploratory findings of the work and informed the theoretical contribution of the research as a framework to guide future public space research. The data was analysed using a grounded approach common to the human-computer-interaction fields and used a novel technique during the analysis of the data: live audio coding.

The findings of the work provide a better understanding of the part mobile technology occupies in outdoor markets in particular and communal public spaces in general. The major contributions of the thesis include the exploration of an outdoor market as an information ground, observations on the importance of mobile technology in outdoor markets, and the design and evaluation of an iterative mobile prototype to encourage social awareness. The capstone of the thesis is the modification of a pre-existing framework from information grounds literature to better guide future researchers and developers. The new framework is explored and justified through the aforementioned iterative prototype.

Acknowledgements

It is a strange thing to try and properly thank everyone who had an impact on a multiple year journey such as a PhD without it ending up being as long as the thesis itself. Nonetheless I will give it a go. The first people who I would like to thank are the participants who took part in this work. There would literally be no research without you giving up your time.

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Finally my family and especially my parents. While I am certain you still have no idea what I did or why I devoted years to doing it, you fully supported me in doing so. It is impossible for me to imagine a world where you did not support me and I still finished the PhD. And, yes, before you ask: I do know this means I will finally have to get a proper job. Happy?

I would like finish this by thanking you, dear reader. I have no idea why you are reading this thesis, but thanks.

Contents

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List of Publications

The following is a list of publications arising from this research:

- Nugent, T., Buttfield-Addison, P., Lueg, C. and Dermoudy, J.: 2015, 'It's useless for that': Finding, frustration, and fun with mobile technology in outdoor markets, *Proceedings of the 78th ASIS&T Annual Meeting: Information Science with Impact: Research in and for the Community*, ASIST '15, American Society for Information Science, Silver Springs, MD, USA, volume 56 pp. 1-9.
  URL: *http://dl.acm.org/citation.cfm?id=2857070.2857126*

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1 Introduction

1.1 Introduction

This is an interesting time to exist: we are now the most industrialised and interconnected people to ever live. In our pockets we carry around devices that previous generations would consider supercomputers. We have near-constant connections to the majority of human knowledge. We are able to learn anything, know anything we desire. We can communicate instantly with friends and family. Regardless of the distance, a person on the other side of the planet is not significantly harder to talk to than the person standing next to us. We can track and study our behaviours. We walk around with sensors that know where we are, know how many calories we are burning, who we hang out with, and what we are doing.

Mobile technology is a part of our lives now. There are now more mobile phones than ever before with literally billions of the devices existing spread across both the industrial and developing world (Pew Research 2014, Kantar Comtech 2015). By 2020 it is forecast that there will be nine billion mobile phones in existence worldwide and smartphones will make

up two thirds of all mobile devices (Ericsson 2015). As of November 2015 there are already seven billion mobile phones and 75% of mobile devices sold in the third quarter of 2015 were smartphones (Ericsson 2015). Going hand-in-hand with this is the rise of mobile subscriptions. Of the 850 million Long-Term Evolution high-speed mobile technology subscriptions in existence, 120 of them came about in the third quarter of 2015 alone (Ericsson 2015). Essentially, humanity is getting more devices and the devices are smarter and more connected than ever before.

Beyond just the sheer numbers is how we are using the devices. Dey, Wac, Ferreira, Tassini, Hong and Ramos (2011) performed a study into the proximity of people to their devices, testing the assumption that just because we have access to such devices does not necessarily mean they are always available. From this study it was found that mobile devices are proximate to their owners, with people keeping their devices within arm's reach approximately 50% of the time and within the same room a staggering almost 90% of the time (Dey et al. 2011). When compared to an earlier study from 2006 by Patel, Kientz, Hayes, Bhat and Abowd investigating the same assumption, it is shown that despite there being a small drop in the number of people keeping the device in arm's reach, there is a large jump in the number who keep it within the same room, 78% versus 88% (Patel et al. 2006, Dey et al. 2011).

The way we are using our mobile devices is changing. A study into the mobile phone practices and the impact on urban culture by Satchell (2008) revealed a number of new urban archetypes of how people are being changed by their mobile devices. From *nomads* and their fluid use of time and space resulting in a new found urban mobility, to the *updaters* who are constantly informing others of their current context and state, the study showed that people are now able to meet fluidly (*"swarming"* as the paper

described it), blur boundaries between the physical and virtual worlds, and even base their identity around their devices and their usage of them (Satchell 2008).

These studies reveal that mobile devices change and impact us; they are now a part of our lives. The future of connectivity and ubiquitous computing is with us now. We are living in it. Technology has facilitated this future.

This thesis looks at this future we are living in. This work studies how mobile technology is being used in busy environments: communal public spaces. These are public environments that encourage social interaction amongst the people within. This definition of a communal public space is derived from information grounds research, primarily the initial premise of an information ground being a space that emerges from the social atmosphere of people being in a space together for myriad reasons. Despite being influenced by information grounds research not all information grounds are communal public spaces, nor are all communal public spaces information grounds, both frameworks have their own place. Communal public spaces encompass a variety of different spaces including outdoor markets, museums, airports, and parks. The primary attributes of these spaces is that they are public, they are populated, and their design (urban, architectural, and technological) encourage social interaction of the people within. This work will investigate how technology is being used in these communal public spaces and how it affects and is affected by the people and the space.

Communal public spaces are the focus for this work for a variety of different reasons. There has been a great deal of study into what could be called communal public spaces, and there is a great deal of research into the impact technology has on different spaces. To combine the two gen-

eral approaches seems obvious. Technology, however, has always been presented as an outsider to the work. Even in more technocentric studies, the technology is presented as the addition, the part that is not naturally part of the environment. This work takes the approach that this is no longer the case: technology is a part of the world we live in as much a part of our lives as the walls that restrict where we can walk or the people whom we consider friends. We lack an understanding into what role technology has in busy environments like communal public spaces. This work will fill this gap in our understanding.

Information grounds (Pettigrew 1999) is one such field of work in which technology has been an afterthought. These are spaces which are created by people who share information as a side-effect of being at a space for an alternative purpose. Despite being studied for approximately fifteen years, the part that technology plays is never focussed upon and rarely added into the overall picture of the space that researchers will create of an information ground, at best it is included as an additional information source. Other attempts at explaining spaces also have this indifference towards technology. The Third Place (Oldenburg and Brissett 1982) is a framework to explain a variety of different spaces that occupy a third social place, one that exists between a person's other common spaces of their home and their work. Third places are intentionally social spaces, where someone can be themselves without the role they have to play at work or in their home. Much like information grounds, the Third Place has been studied for decades and technology is still seen as an outsider. There is work investigating technological third places (Hacking HCI3P 2014) and there is work investigating how technology can support third places, but the focus again shied away from the technology.

Even the fields with a heavier focus and appreciation on the technology,

such as human computer interaction, ubiquitous computing, and urban informatics have considered technology a step removed from the world itself. Early studies in these domains focussed primarily on how to build systems, the challenges overcome provided insight into the specific technological artefacts built, but rarely focussed on the world in the systems were to be used. This was particularly made evident in mobile human computer interaction research when a review of the field showed a very large bias towards the aforementioned and little work being done on simply understanding a space (Kjeldskov and Graham 2003). Over time this approach has changed and the research is looking increasingly at the space where the technology is intended to exist before even beginning to implement anything. With this new focus we now have a good understanding of how to introduce and discover what impact technology has on people. Even this however, still sees the technology as distinct from the world itself.

Essentially our understanding of why, how, and what part technology plays in communal public spaces is lacking.

1.2 Research Premise

This work began with the premise *that there is an insufficient understanding into how technology can support communal public spaces.* A review of the existing literature into communal public spaces and technology was performed and a series of pertinent observations were made:

- There is a lack of research and understanding into how people, space, and technology interact.
- There is a lack of research into how technology can support people's activities and goals inside public space.

- Public spaces are poorly understood from a design perspective: there is no framework specifically for understanding communal public space from a technology perspective only a myriad different related topics.

This key premise and the high level literature observations led to the creation of the three objectives for this work and gave a scope to constrain the work.

1.2.1 Objectives

The three objectives of the work are as follows:

1. *to uncover what role technology plays in communal public space.* Technology has alway been an outsider to theoretical understanding of place, either as the focus that all other objectives must point to, or as the addition that is tacked onto the end. This research seeks to gain an understanding into how technology fits into communal public space. Based on the methodological approach this work follows, this understanding will most likely take the form of a framework.

2. *to understand what friction around technology use in communal public spaces currently exists.* No technological solution will provide a perfect answer for everyone. What are the current issues that people in communal public spaces are having with technology? This could be specific issues with how technology allows a person to complete a goal or specific areas where there is no solution offered currently.

3. *to see what technological artefacts can be introduced to better integrate technology into people's activities in communal public spaces.* The research sought to develop a prototype solution to help alleviate some of the friction that is currently being experienced at communal public spaces.

1.2.2 Scope

This research was scoped to focus on:

- *outdoor markets as an example of communal public spaces.* As stated earlier, a great many places fall under the banner of communal public spaces. Attempting to study all of them would be infeasible. Outdoor markets are an archetypal communal public space and were chosen for two expedient reasons: the researcher has prior experience with them, and an outdoor market existed in close proximity to the researcher's residence.

- *mobile technology.* The nature of outdoor markets makes immobile technology infeasible a great deal of the time. Additionally, mobile technology, mostly in the form of smartphones, is the primary means of technology people worldwide possess and the researcher has prior experience in the field.

- *current activities being undertaken at outdoor markets.* Any intervention should be based on the current understanding of the space. As there is only limited understanding of how mobile technology exists in communal public spaces, attempting to introduce a new technological artefact would be folly.

1.3 Research Approach

This work uses the Participatory-Action-Design-Research (PADR) methodological approach (Bilandzic and Venable 2011) to help guide the work. PADR was chosen for a variety of reasons. Firstly it comes from the urban informatics research field which this research considers the currently extant field that is closest to fully appreciating the interplay between space

and technology. Secondly PADR is action oriented: it is designed to help bring about a space appropriate technological change. While this research does not necessarily believe a technological intervention will be the best choice, PADR allows for any form of intervention (although its focus is obviously on technical). Finally, PADR supports an interpretivist focus on the work, an approach to which the researcher also subscribes.

1.4 Summary

This work found the reasons behind people's use of technology in communal public spaces as well as the areas where technology is currently failing people, created a series of personas to help capture the experience of a communal public space, introduced a technological intervention to aid in better integrating technology into communal public spaces, and presents the positive responses to the intervention. These findings show the importance that technology now plays in communal public spaces and in people's lives in general. These findings also offer guidance to future researchers who wish to better understand a communal public space, or similar environments, or to aid developers in the design and implementation of technological artefacts by giving them a better picture into how technology exists in such environments. This thesis concludes by offering future directions for the work, both in the technological and the theoretical spaces.

1.4.1 Thesis Structure

The structure of the remainder of this thesis is as follows:

- Chapter 2 presents the literature review that fully explains the context and knowledge gap this work fills.

- Chapter 3 describes the methodological approach — participatory action design research — that this work uses.
- Chapter 4 covers the initial exploratory stages of this work, investigating how technology currently exists in communal public spaces.
- Chapter 5 covers all technological interventions introduced and their impact on the space.
- Chapter 6 presents the analysis of all the experimental work, discusses their implications, and a framework encapsulating these is presented.
- Chapter 7 concludes the thesis by presenting a summary of the work, its impact, and the future paths on which this work could be taken.

2

Literature Review

This chapter investigates the existing literature on communal public spaces, broadly presented in two main categories: passive and active. A review of literature confirmed the initial research premise that there is insufficient research into what part technology plays in communal public spaces and that more research into communal public spaces that takes a holistic approach is needed.

2.1 Introduction

For the first time the dream of the ubiquitous computer (Weiser 1991) is within reach. Mobile technology has given us access to nearly all the information and sensors we need to better determine where, what, and why we are doing something. We are now in (or are just about to enter) what Kjeldskov (2013) calls the Digital Ecosystems wave of mobile computing. We are onto the stage where we start to build digital worlds—trying to link everything together—where space and technology hopefully will become one.

There is a problem, however, with this next phase of mobile comput-

ing: we do not fully understand how all the pieces are going to fit together. Most of the research into how technology is being used across different spaces was done far earlier, in between what Kjeldskov (2013) called the Connectivity Wave (1990s) and the App Phase (2000s). This period is when the bulk of context awareness, location awareness, and ubiquitous computing research from a mobile perspective was performed, arguably culminating in 2007 with the Conference on Human Factors in Computing Systems workshop into mobile social interactions which created categories of mobile social interactions (Fröhlich, Simon, Baillie, Roberts, Murry-Smith, Jones and Nair 2007, Bilandzic and Foth 2012).

The world has changed a lot since 2007. Mobile phones now outnumber desktop computers (Kjeldskov 2013) and the way we use them has also changed. The poster children for mobile social interaction—dodgeball and Foursquare (Bilandzic and Foth 2012)—have changed. One has disappeared—to be replace by Google Latitude (now also gone (Google Inc. 2013))—and the other has changed from being a social tool to a recommendation engine, with the social aspects spun off into a secondary product (Foursquare Labs 2014). Despite this, research in the mobile field is focussing more on the Digital Ecosystem and less on seeing how people use mobile technology and how mobile technology affects spaces.

Before continuing it is worth restating what a communal public spaces are and why they are the focus of the research. A communal public space is a public space that encourages social interaction amongst the people participating within. This definition is intentionally broad and is based on the initial premise of information grounds: *"synergistic environments temporarily created when people come together for a singular purpose but from whose behaviour emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information."* by Fisher, Naumer, Durrance, Stromski and

Christiansen (2005, p.1). A great number of different places which would not be considered information grounds such as museums or libraries are valid communal public spaces. Conversely some places which are (or could be considered) information grounds such as private clubs or nursing homes are not communal public spaces due to their restrictive nature around participation, they fail the *public* component of public space.

Research into communal public spaces falls under a variety of different fields and disciplines which are grouped together in this work into two broad categories: active and passive. These names come from Chen and Kotz (2000)'s review into context awareness, where the systems fell into two groups: those that tried to make a change (the active ones) and those that observed and presented information for others to decide what to do (the passive systems). Neither approach is better than the other and neither is solely passive or active, with each borrowing parts from the other. The distinction exists in this work solely to simplify the discussion.

2.1.1 Chapter Structure

The remainder of this chapter is as follows:

- Section 2.2 discusses the difference between space and place, creating definitions to be used throughout the rest of the thesis.
- Section 2.3 briefly talks about technological appropriation and the impact it has on this work.
- Sections 2.4 to 2.6 present and discuss the work performed in the passive fields.
- Sections 2.7 and 2.8 presents and discusses the active fields used in this research and previous work performed in the active fields.

- Section 2.9 concludes the work by discussing the implications of the previous work, the trends within, the gaps identified, and the next steps of this work.

2.2 The Place Pickle

This work is based around the concept of gaining a better understanding of how technology is used in, affected by, and how it affects communal public space. The very concept of *public space* itself is a very overloaded one, even before technology comes into play. As well, there are a great number of different research domains from which this work can take inspiration. The major fields used in this work fall under the general banners of computing and awareness, library informatics and social studies, and urban planning and design, amongst others. As such there are many conflicting terms and definitions for what are otherwise quite similar ideas. One of the more contested terms in both fields is the notion of place and space and the difference and similarities of the terms. Even internally in the different fields there appears to be no agreement on which terminology is best suited to explain the concepts. The following discussion is based primarily upon Harrison and Dourish's (1996) "Re-Place-ing Space," which evolved out of their research into collaborative virtual environments, as well as the follow up discussion "Re-Space-ing Place" ten years later (Dourish 2006b).

2.2.1 Space

Space is a relatively straight-forward enough term to understand. Space encompasses the geometrical and physical components that will frame and constrain any interaction people can have both with the space itself and with any people who are participating within. There is no requirement

that the space itself be a real-world location or structure. Everything that space is applies as much to a virtual or augmented world as much as it does to the real.

There are several properties, however, that combine to make a space a space. The first is a shared orientation. Everyone in a space, whether that be real or virtual, has a shared set of orientation rules. In the real world these are concepts like *up* meaning towards the sky and enable communication such as "on top the the fridge" or "near the door" to work with minimal confusion.

Space also has proximity and partitioning, both of which relate to the idea that actions are related to a location and this can and will be used to influence those actions. This may be as simple as a voice only being able to be heard over a short distance resulting in people involved in conversations generally being clustered together, or interaction being possible only with objects nearby. It can also be more complicated: in a virtual space the partitioning might be chat rooms where only people in the room can talk to others, or in a game that models radio waves and moving over a hill prevents communication with the rest of the players.

Finally there is presence and awareness. These describe how people are capable of not only determining that others are nearby based upon their activities but also to use these activities as indicators of how to integrate their own activities into and with these people's, for example if a person looks very busy, they likely are. Whilst this seems trivial and an implicit part of our everyday lives, this has quite an impact on how people will use the space: areas which allow this awareness will change the behaviour of the people in the space.

2.2.2 Place

Place is a slightly less obvious concept to understand when compared to space, however it is a much simpler concept to explain. Place is the *behavioural appropriateness* for a space.

The way in which people act and live will be more heavily influenced by both what they are trying to achieve and by their own social fabric than it will be changed because of the space they are occupying. For example: a function hall can be used for both a wedding reception and a wake, yet despite no change in the space the way people act within such the space will be significantly different. This is neatly summed up by Harrison and Dourish's (1996, p.70) line *"a house might keep out the wind and the rain, but a home is where we live"*.

In essence we exist in a space yet we act in a place, a place is inside a space.

An important component in forming a place from a space is appropriation: the act of taking something for one's own use. The importance of appropriation is very evident in the case of the VideoWindow (Fish, Kraut and Chalfonte 1990) and the Xerox link MediaSpaces (Bly, Harrison and Irwin 1993). Both were early prototype office video-link systems designed to allow for hybrid offices to be created by video-linking two distinct offices together. The VideoWindow was arguably the superior of the two, supporting a higher quality of video and projection system allowing for a better feeling of presence. The side-effect of this is the system had very complex and expensive looking equipment, whereas Xerox link used less expensive equipment on wheeled tripods. From these two systems, one encouraged appropriation and the other did not, as such during a post-mortem of VideoWindow it was found that the system seemed to *"lack*

something" leading to its inevitable demise (Fish et al. 1990, p.9). During their investigation into space and place Harrison and Dourish (1996) determined it was appropriation that was the "something" lacking. People were put off by the complex system and so never adapted it for their own use, a problem that the simpler Xerox link system did not have. For more discussion into appropriation see Section 2.3.

2.2.3 Place and Space

The above explanations of space and place imply a structure for how space and place interact with one another: that space is the framework for the place to occur, and that the place comes after the space. This idea is called the *"layer-cake model"*, a name from Kling, McKim, Fortuna and King's (2000) study into distributed collaborative laboratories—rather inelegantly named collaboratories—and how they can apply an actor-network theory to their existence and use. Kling et al. (2000) looked at collaboratories and broke the elements of the people who use them and the technical aspects of the lab into a layered approach. Each component built on top of the previous. A large part of the reasoning behind the layer-cake model was to try and explain that there is a great deal more complexity in how technical artefacts and social practices interact.

During a second investigation into how space and place interact, Dourish (2006b) stated that the layer-cake model of space and place does not hold. Dourish (2006b) associated mathematical properties with social practices, and from this then connected how issues in the implementation of the Mercator map projection (Monmonier 2010) with its heavy focus on northern regions for European navigation purposes reflects a social practice of its creators despite being borne out of a space, resulting in a distorted appearance of the northern parts of the planet. This is then tenuously linked

back to space and place, resulting in the declaration that space is derived from place and not the other way around. This is then used to state that space and place are both social practices and we as people create them as we encounter them. While it is true that a map projection is a social practice and reflects the desires and goals of its creator, this work argues that a map is not a space but a representation of one. A map is no more a space representing the Earth than an architect's drawing of a house is a building.

For this thesis the layer-cake model is adopted, with a place being inside a space due to its simplicity to understand. This approach is supported by other researchers' investigations into the differences between space and place, in particular De Certeau's (1984) tactical spaces, Lefebvre's (1991) triad of perceived, conceived, and lived spaces, or Soja's (1996) counter-spaces all reinforce the concept that a space can be built but a place must emerge from within. Hence, in general throughout this work, when talking about space it means the environment and physical attributes that a place possesses, and when talking about place it relates to the social environment and ways in which we use the space.

2.3 Appropriation

Appropriation is a concept that was introduced in the above section. At its most basic, appropriation relates to the difference between technology-as-designed and technology-as-used (Carroll, Howard, Vetere, Peck and Murphy 2002, Carroll, Howard, Peck and Murphy 2003). Appropriation is the means by which technology moves from the state of technology-as-designed to technology-as-used.

In many cases appropriation comes down to how easy a system is for a person to use for their own goals, not for the goals of the developers. A

system that is easy to appropriate is flexible, allowing its users to determine how it is to be used, putting as few limitations on them as possible. This does mean a system can be designed for one purpose and never be used for this purpose, but still be remarkably successful and popular amongst its users for the goals they have given it.

The concept of a lifecycle of technological adoption is an old idea, from the early work into innovation, adoption, and acceptance (Davis 1989) to the work into pre- and post-adoption of information systems work (Karahanna, Straub and Chervany 1999). Few studies, however, have a focus on how technology moves between the stages of adoption (Carroll et al. 2003).

In their investigation into the adoption of information systems projects, Carroll et al. (2002) noted that people were adopting technology through three distinct levels, taken from Carroll et al. (2002, 2003):

1. *Encounter*: the user first encounters the technology and begins to form initial judgements about its usefulness; should they consider it worth further exploration the process of appropriation begins.

2. *Adopt and Adapt*: this is where the user starts to explore the technology in greater depth. It is at this point the user will either fully adopt the technology and adapt parts of it for their own use–called appropriation–or abandon (or as Carroll et al. called it: disappropriate) the technology.

3. *Long term use*: this final level is when the user is using the technology long term. This is not a static level and as the users use technology they will be readjusting their decision to continue using it.

The implications of appropriation are staggering. As was discussed in Section 2.2, a system which is not easy to appropriate will not be adopted

long term by people regardless of any technological superiority it may possess. As such, when discussing any previous research or any prototypes developed as part of this research, the ease or lack of appropriation is kept at the forefront as an important aspect of the system.

2.4 Information Grounds

Information grounds are a social constructionist theory for explaining how information flow occurs in places that exist for a primary purpose other than information sharing (Pettigrew 1999). Information grounds emerged from a study into information flow at a foot clinic (Pettigrew 1999). When the work began, there was an expectation of a very strong dyadic information flow between the patients and the nurses providing treatment. As the place was explored and the flow of information mapped out, the dyadic structure between the nurses and patients was not being reflected in how information was moving about the clinic (Pettigrew 1999). Information grounds are the first of the passive research fields that formed this work and were also the initial starting point for this research before moving onto communal public spaces.

At their most basic, an information ground is a place that exists for one purpose but, because of the nature of people and by way of information sharing, is inevitably used outside of the structure provided. The original researcher of information grounds Fisher née Pettigrew (1999) described them as:

> *"synergistic environments temporarily created when people come together for a singular purpose but from whose behaviour emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information."*

Fisher et al. (2005, p.1)

This idea is not something particularly revolutionary; it is something that we implicitly understand and do simply as social beings. This basic idea, however, was then expanded out into seven propositions by Fisher et al. (2004, 2005) that better define the concept:

- Information grounds can occur anywhere, in any type of temporal setting, and are predicated on the presence of individuals.
- People gather at information grounds for a primary, instrumental purpose other than information sharing.
- Information grounds are attended by different social types, most, if not all, of whom play expected and important, albeit different, roles in information flow.
- Social interaction is a primary activity at information grounds such that information flow is a by-product.
- People engage in formal and informal information sharing, and information flow occurs in many directions.
- People use information obtained at information grounds in alternative ways and benefit along physical, social, affective and cognitive dimensions.
- Many sub-contexts exist within information grounds and are based on people's perspectives and physical factors; together these sub-contexts form a grand context.

It is from these propositions that information grounds can be better discussed, analysed, and applied. The remainder of this section will present

and analyse the seven propositions, discussing the sub-contexts inside of an information ground before finally finishing up on the people, place, and information trichotomy approach for describing an information ground.

It is worth mentioning that when discussing places identified as—or very likely to be—information grounds, it is not worth getting caught up in the precise minutiae of whether a place matches every specification of an information ground or not. This work takes the approach that this theory, and all theories presented, are better understood as scaffolding to help structure discussion and thought. Overly focussing on tiny details will only distract from seeing what good can be taken from the disparate fields.

2.4.1 The Propositions

As mentioned in Section 2.4, the basic idea of an information ground is that they are created when people come together, sharing information as a side-effect of this congregation. This is further refined into seven propositions that go into a greater amount of detail as to what it is that makes a particular place an information ground. Of the seven propositions there is one commonality to all of them: people. People are at the heart of information grounds. Whilst this does not help in gaining a better understanding into what an information ground is, it does show the primary focus of them: you can not have an information ground without people.

The seven propositions can be broadly broken up into three categories: flow, structure and purpose. What follows is a breakdown of the these categories, the propositions that reside inside them, and how they relate to one another.

Flow

The flow category relates to how information inside an information ground flows and moves through the people that are a part of it. The propositions that are a part of this category come from Fisher et al. (2004, p.756) and are as follows:

- *"information grounds are attended by different social types, most, if not all, of whom play expected and important, albeit different, roles in information flow"*
- *"people engage in formal and informal information sharing, and information flow occurs in many directions."*

These propositions describe the way in which information flows inside an information grounds. In particular, these two propositions indicate how information flow is unrestricted as well as both formal (such as teacher-to-student) and informal (student-to-student). This omnidirectional flow was discovered during an investigation into a foot clinic. It was found that while there was very formal nurse to patient information flow, there was also a great deal of informal side-ways information being shared: nurse to nurse, client to client, and client to nurse (Pettigrew 1999).

Structure

The structure propositions relate to the structure of the information ground place itself. These propositions come from Fisher et al. (2004, p.756-757) and are as follows:

- *"information grounds can occur anywhere, in any type of temporal setting and are predicated on the presence of individuals"*

- *"many sub-contexts exist within information grounds and are based on people's perspectives and physical factors; together these sub-contexts form a grand context"*

Structure in this capability could comprise the physical location such as the building or layout of furniture that make up the information ground space, and the many types of people that make up a particular information ground.

Purpose

The purpose propositions come from (Fisher et al. 2004, p.756) and are as follows:

- *"people gather at information grounds for a primary, instrumental purpose other than information sharing"*
- *"social interaction is a primary activity at information grounds such that information flow is a by-product"*
- *"people use information obtained at information grounds in alternative ways, and benefit along physical, social, affective and cognitive dimensions"*

The purpose of the information ground is somewhat more complex than the other two. The reasons people meet at a particular space will be many and varied and will depend on the particular goal of those there and the reason for the place's existence.

In the case of previously identified information grounds (Fisher et al. 2005), taking a place of worship as an example, the reason people go to a particular place of worship is going to be unique to them. They will not be attending with the goal of gaining information, but it will happen regardless as a side-effect of people being together and communicating in

the one place. What people do with this information is also varied and again will not necessarily have anything to do with the reason the person attended the place. This does mean that a place where people are meeting for the primary purpose of information gathering and dissemination will not be an information ground.

The propositions inside this category are the ones that most closely match the initial definition of information grounds described in Section 2.4. As the propositions define a place as an information ground, they are all important. It is the opinion of the researcher, however, that the Purpose category of propositions is the core that most completely defines an information ground. This is partially due to the Purpose propositions similarity to the initial definition and partly due to the propositions difference from the similar theories. It is the purpose that makes an information ground, as a theory, unique.

As with any framework dealing with people and complex environments, it is difficult to precisely apply them to a single specific place. Whether a particular place is an information ground or not is a very difficult conclusion to draw. As such any one place that may be seen as an information ground by one person may be seen as not one by another. However, as stated earlier, getting bogged down in tiny differences does not aid in understanding what is going on.

2.4.2 Sub-contexts and the grand context

The final information ground proposition *"many sub-contexts exist within information grounds and are based on people's perspectives and physical factors; together these sub-contexts form a grand context"* (Fisher et al. 2004, p.756) is part of the Structure (Section 2.4.1) grouping of the propositions and affirms that information grounds are context-rich. The sub-contexts can

be any number of different events or factors such as the physical layout of the space or how busy an information ground participant is.

For example, in the case of the original study into information grounds at a foot clinic, Pettigrew (1999) identified four major sub-contexts:

- *Clinical activities*: the waiting and treatment process.
- *Physical environment*: the layout of the building, availability of refreshments and the weather.
- *Nurses situation*: knowledge of local resources and patients, availability of the nurses to the patients.
- *Patients situation*: desire to interact and their personal circumstances.

These sub-contexts, taken all together, give an overall grand context for the entire information ground and allow the major components of the information ground to be seen.

The sub-contexts and seven propositions have in many ways been superseded by the People, Place, and Information trichotomy (see Section 2.4.3). This trichotomy has the ability to identify the same sub-contexts, frame them together, and see how they interact with the other elements of the information ground as opposed to simply listing them as has been done in past research. Identifying the sub-contexts in detail does still have an advantage over the trichotomy: it allows for a greater snapshot to be taken of individual components of the information ground, whereas the trichotomy is only going to be providing an overview–albeit a useful one–of an information ground.

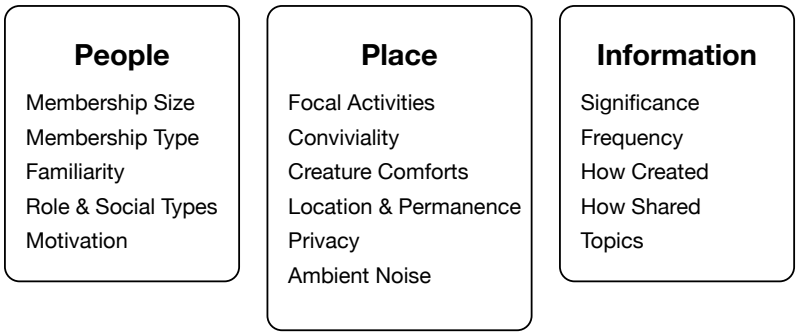


Figure 2.1: The PPI Trichotomy.
Reproduction from Fisher et al. (2006)

2.4.3 People, Place, and Information Trichotomy

The People, Place, and Information Trichotomy was created from the largest information grounds study, of 729 university students. This study attempted to define the characteristics of an information ground specifically for the purposes of informing system design and for optimising information ground spaces (Fisher et al. 2006). The numerous characteristics identified were then grouped into three interlinked categories of people, place, and information.[1]

The People-Place-Information trichotomy was created for a variety of different reasons, one of which was to gain insight into the general properties of information grounds through a large scale survey, in effect creating an information grounds topology. Another reason was to allow people to start using information grounds, because of the understanding and characteristics the trichotomy provides, and to start designing and optimising systems (although this was not expanded upon in the initial work). The information ground characteristics and the discussion below about them

[1]here the term place is being used as a combination of both place and space, see Section 2.2.

is based upon the study by Fisher et al. (2006).

People characteristics

- *Membership size*: the number of people who are a part of the information ground.
- *Membership type*: is it open to anyone or closed?
- *Familiarity*: how well known are the members of the information ground to each other?
- *Actor roles and social types*: the role and position that the person plays in the information ground.
- *Motivation*: a person's reason for attending the information ground.

Membership size and type are simple enough concepts to understand. How many people are a part of the information ground? Is access to the information ground open for anyone or restricted (which will generally be the case for private clubs or gyms)? Of the identified information grounds during the study (Fisher et al. 2006), slightly over 40% consisted of 2–10 people, with progressively smaller percentages as the size of the information ground members grew until only 18% had membership of greater than 50 people. The vast majority of information grounds, 70.4%, had an open membership type. This is an unsurprising result as people are going to participate more in a place that allows to join than one that has requirements attached. This does still indicate a large number of people participate in restrictive information grounds.

Familiarity was one of the newer concepts to be formalised. Previous research into information grounds had identified the difference between information coming from *strong* and *weak* relationships amongst people

(Pettigrew 1999, Fisher et al. 2005), but this was expanded out to four different familiarity levels amongst people at an information ground:

- close friend.
- acquaintance.
- someone recognisable.
- complete stranger.

The close friend level of familiarity was identified as the most common link amongst interacting people at an information ground. This observation melds well with the previously identified result of trusting information from strongly linked people more than any other source of information (Fisher et al. 2005).

The actor roles and social types are two interrelated but slightly different concepts. Actor roles relate to the role that the person participating in the information ground will be playing when they are there, so in the case of the original study most of the people have the actor role of a student (Fisher et al. 2005).

Social types are related to but different from a role. Whereas the role is the part in which a person will be playing, their social type is the type of person they are in that place. Lofland and Lofland Lyn (1995, p.106) described them as *"constructs that fall, conceptually, somewhere between an individual, idiosyncratic behaviour on the one side and formal or informal role behaviour on the other side"*. Pendleton and Chatman (1998, p.737) explained them as *"broad but typical social actions... [that] are not intended to convey an actual person but the culmination of exhibited behaviour that forms a specific perspective"*. This work takes the definition provided by Fisher et al. (2005, p.1) *"they indicate your position in the information food chain"*.

Social types in effect give a person a position outside of their role. No social types were identified in the study which created the PPI, but previously identified social types include *monitors* and *blunters* from a study into women with multiple sclerosis (Baker 1996, Baker and Pettigrew 1999), and *bitch guards*, *brides*, and *studs* from a study into women's prisons (Chatman 1999, 2000, Pendleton and Chatman 1998).

While actor roles and social types are different concepts they are also remarkably similar. An actor role is the part intended to be played and the social type is the position in the social chain when playing that role. The two are close enough that this work takes the approach that both are in effect the same and a role or social type will only be seen as different if people choose to define themselves with that distinction.

Motivation is the reason the person has attended the information ground, their purpose for going (Fisher et al. 2006). In the case of a doctor's waiting room, the motivation would be to attend an appointment. As such an information ground may have as many different motivations as there are people who are a part of it. A special case of motivation is the concept of a hostage information ground. This is where the motivation of the person is compulsory instead of voluntary. Depending on the person, the waiting room would be a hostage information ground. Other examples would be public transport or classrooms.

Hostage information grounds are of particular interest as they are one of the more unique components of information grounds. Many of the other fields and theories inside the passive category assume that the person is there willingly; some even require it. Information grounds will still exist and the properties and aspects of them do not change even when the people participating do not wish to do so.

Place characteristics

The following is the list of the Place characteristics in the PPI trichotomy and relate to what this work calls place and space.

- *Focal activities*: similar to motivation, the activities that draw a person to an information ground.
- *Conviviality*: how convivial the information grounds atmosphere is for its members.
- *Creature comforts*: how comfortable or accommodating the space is for its members.
- *Location and permanence*: how well established and convenient the information ground is for its members.
- *Privacy*: the members' perception of the information ground's privacy level.
- *Ambient noise*: how conducive a place is for conversation.

Most of these characteristics are immediately obvious; they relate to reasons why a person is drawn to a place (other than their motivation to attend) and how nice it is once they are there. All of these properties are more relevant to willing participants than to hostage participants. These properties are essentially meaningless to someone who does not want to be a part of an information ground. This may be an oversight in the PPI itself or a misunderstanding by the researcher, but it does appear that while the PPI can capture certain characteristics these are not necessarily applicable to every situation.

Information characteristics

The following is the list of characteristics relating to the Information component of the PPI trichotomy.

- *Significance*: an indication of how useful the members consider the information gained to be.
- *Frequency discussed*: how often a single topic is discussed and how often new topics are discussed.
- *How created and shared*: how the information shared is discovered, such as face-to-face discussion or vicariously.
- *Topics*: the range of topics covered at the information ground, classified as *personal*, *local*, or *world*.

The Information characteristics relate to what kind of information is discussed, how it is transferred and how often, and how important it is to the information ground participants.

2.4.4 Information Grounds and Computing

With one of the PPI's purposes behind its creation (see Section 2.4.3) being to help develop systems for information grounds, *"a first step at organising information ground attributes for the purpose of informing system design"* (Fisher et al. 2006, p.1). It could be assumed then that there has been a great deal of work into how computing technology and information grounds work together. This is not the case. There is an absence of research into how technology of any kind impacts, or is impacted by, information grounds. This section will look at the limited research into how computing

technology has been presented in information grounds research and investigate some attempts at the integration more technology into information grounds.

Technology use in information grounds

The theory of Information grounds is relatively new—sufficiently recent enough that most information grounds researched are very likely to have one or more computing devices as part of the place. What part this plays in the information ground has been poorly reported, with computing technology often being presented as an additional information source, a new way that people in the information ground can generate and share information. It most commonly appears in the *how created and shared* category in the PPI.

In a large ethnographic study into immigrants at a New York Public Library (arguably a place that is not an information ground), Fisher et al. (2004) investigated the information ground that emerged in the library. The only mention of computing in the study revolved around the library's public computers, which were used by the immigrants for maintaining cultural and personal connections: *"They remain in touch with their roots through technology services"*, and for building up technical literacy: *"They can practice their technology skills with library computers"* (Fisher et al. 2004, p.761-762).

A much larger study using a phone survey of 612 people's information habits and information grounds revealed that the most common and trusted information source was close friends and family, but the internet was the second most used source (Fisher et al. 2005). This approach, however, again sees the computer as a magical device. The assumption that the computer is simply an additional information source is a powerful one in information grounds research.

A study investigating the information habits of *tweens* looked in great depth at the information habits of people aged 9–13 through a variety of different theoretical lenses (Meyers, Fisher and Marcoux 2009, p.322). This study produced numerous different observations about the relevance of technology to this age group, including the importance of mobile devices. Cell-phones were the preferred method of tool-based communication (Meyers et al. 2009). This importance was echoed again when the children were asked what components made them consider one information ground over another. Computer access was one of the four listed (Meyers et al. 2009). Other interesting observations related to how they used computers, with there being less of an insight into the device and more into use of *"memorised strategies and common routes"* to finding information online (Meyers et al. 2009, p.322). Even when there were computers available for every child, they would commonly work together and share the single computer. They were using the devices socially (Meyers et al. 2009).

This study may well be the most in-depth information grounds research that had a focus on computing. Even though the study still took the approach that the computer was mostly just a device to provide additional information, it showed that computing technology is now an important tool for information gathering and social purposes.

Digital Information Grounds

The spaces the information grounds exist within do not have to be physical. They can be virtual: purely digital walls and constructs existing only within the bounds of technology. Such information grounds would obviously be different to those previously discussed, but should still exhibit the characteristics of an information ground.

One attempt at investigating digital information grounds was an analy-

sis of the early mobile social network Slam (Counts and Fisher 2008). Slam was both a Windows Mobile application with an interface akin to a traditional SMS application as well as a desktop application similar to a chat system. The social network was based around messages, where messages could be sent directly to an individual or to a preconfigured Slam group. Messages were text, an image, or both (*Slam* 2003).

Whilst Slam was not created specifically to be an information ground, it was nonetheless analysed as if it was one. Indeed the entire premise of the particular research was that the information grounds framework could be used as a lens to understand mobile social software (Counts and Fisher 2008). As such, this study is a good example to see how information grounds hold up when applied to a fully digital place.

The conclusions of the study revealed some issues with the information grounds framework as it currently existed when applied to such different environments than that for which it was created. Any modification of the framework should be a good thing; the constant challenging and adaptation of ideas is how we advance our understanding. In the case of the Slam study, however, there was more than an adaptation.

Some of the propositions required minor tweaks to the definition, such as changing the initial requirement that people congregate physically to simply congregating regardless of the medium. There were two propositions that did not fit with the observed place: *"People gather at information grounds for a primary, instrumental purpose other than information sharing"* (Fisher et al. 2006, p.1) and *"Social interaction is a primary activity at information grounds such that information flow is a by-product"* (Fisher et al. 2006, p.1).

The information sharing amongst participants was very specific and the reason for people being a part of the Slam network was for the infor-

mation it generated. The amount of cross-chatter amongst people in the Slam network was reduced simply because of the technological nature of the interface making it difficult to initiate a conversation with a nearby person (Counts and Fisher 2008). The way people were using Slam was in direct opposition to those propositions.

The conflicting propositions are both from the Purpose category (see Section 2.4.1), and, as stated, this research considers this to be the critical category of propositions that make up an information ground. To require significant modification to, or removal of the defining components of an information ground to fit a place into the framework is the same as a place *not* being an information ground in the eyes of this researcher.

The Slam study did, however, still find that mobile technology does *"mediate barriers of time and place that hinder the formation of information grounds in traditional physical settings"* (Counts and Fisher 2008, p.161). This indicates that there still is potential in using mobile technology to get around the issue of needing people to be co-located to communicate in an information ground.

Slam was not the only digital place investigated as an information ground. Another study looked at the information behaviours of players in Second Life, exploring the place as if it were an information ground (Lin, Eisenberg and Marino 2010). Despite being only a short study it was discovered that Second Life functioned quite well as an information ground, with people integrating the web outside of the game in conjunction with the virtual world of the game itself and information flowing between players and people (Lin et al. 2010). Why Second Life did better than Slam as an information ground may be due to the shared common ground between the players of Second Life that participants of Slam did not possess. Not everything about Second Life worked perfectly as an information ground. In partic-

ular, despite a shared common ground there were significant issues with shared awareness amongst people in the virtual world (Lin et al. 2010). The study of Second Life as an information ground offers tantalising evidence that technology is not a barrier preventing the creation of a virtual information ground, but it does still present challenges over a physical space.

Technology Mediated Information Grounds

Thus far the information grounds research presented has examined how technology has been used in information grounds or as information grounds. Finally, there is the situation of using technology to help create or sustain information grounds. Arguably, in the case of the Second Life or Slam information grounds (Counts and Fisher 2008, Lin et al. 2010), the technology was required to keep the ground alive. It was not so much technology mediated rather as the technology took the place of the physical environment that would normally support an information ground. This section will discuss a single case by Kelder and Lueg (2009) of using technology to help encourage an information ground to form.

So far when the term technology has been used it is in relation to computing technology. In this instance however, the technology was Pink branding (Kelder and Lueg 2009, 2011), posters and signage applied to stalls. This branding is far less advanced than computing technology but just as effective.

Kelder and Lueg (2011) performed a 12 month ethnographic study into information seeking based both around the breast cancer awareness Pink branding (Pink Ribbon Inc. 2014) and the mobile nature of a Tasmanian Community Education and Recruitment (CER) officer attempting to spread awareness of breast cancer (Kelder and Lueg 2009, 2011). A part of the CER officer's activities involved setting up breast cancer awareness stalls

at various events around Tasmania. These awareness stalls used the Pink branding to help identify their purpose to the general public. From these stalls the researchers observed and argued that the stalls were being transformed into an information ground, all being mediated by the initial Pink branding as an impetus for the initial attraction to or purpose of the information ground (Kelder and Lueg 2009, 2011).

This ad-hoc information ground was acknowledged to have some issues, primarily with the purpose of the information ground. A stall does not just appear by itself and was actively created with the goal in mind of spreading information about breast cancer. This obviously is at odds with the information grounds proposition *"People gather at information grounds for a primary, instrumental purpose other than information sharing"* (Fisher et al. 2004, p.756). However, as stated in the research, it was the branding that created the attraction, not the information, which is why the researchers declared the stall an information ground. A less focussed aspect of the research is the mobile nature of the ad-hoc information ground. New information grounds were being formed as the CER officer moved the stalls around the state, all through the medium of the Pink branding. The Pink branding when being applied to stalls was causing the creation of information grounds.

The above study is so far the only one to explore how people can create information grounds using technology, and even then it was not the focus of the research but an observed aside as part of their study. Nonetheless it does show that there is some potential towards creating information grounds on an ad-hoc basis.

2.4.5 Summary

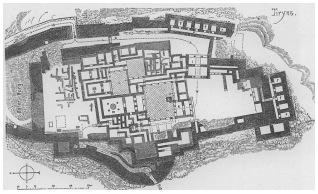
Section 2.4 presented research on information grounds: *"synergistic environments temporarily created when people come together for a singular purpose but from whose behaviour emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information"* Fisher et al. (2005, p.1). These are places where information sharing occurs as a side-effect of people coming together in a space for a purpose other than information sharing. Arising out of a study of information flow in a nursing clinic, information grounds have been heavily investigated and their defining characteristics heavily optimised.

The People-Place-Information (PPI) trichotomy was born from the largest study of information grounds. This framework provides a breakdown of the major properties of an information ground into three distinct scaffolds: People, Place, and Information. Some of the reasons behind the creation of the PPI was for optimising information grounds and to inform system design for information grounds.

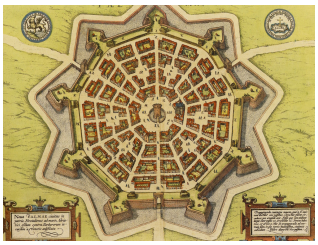
Unfortunately, there is poor understanding of computing technology in information grounds, even with these goals of the PPI in mind. Few studies have looked explicitly at what and how computing impacts an information ground and the PPI is currently unused for aiding system design. There are, however, tantalising hints. Technology has been used to encourage information grounds to grow on an ad-hoc basis and to provide a space for information grounds to exist. Studies have also shown that computing is becoming a more important part of information grounds. There needs to be more research to see what role computing has to play in information grounds.

2.5 Urban Design

Urban design is a field with a long history behind it. Urban design's goal is to build the ideal city for people. The problem is that an ideal city is never truly possible and what worked in the past will likely not be ideal for today.



(a) Greek Palace City



(b) Bastion City

(c) High-density Apartments

Figure 2.2: Ideal cities throughout time

An amalgam of numerous different fields–the list of which changes over time–urban design includes fields such as urban planning, architecture, city planning, military, sociology, and engineering research under its very large banner.

Despite a long history, urban design has undergone quite a rapid change in the last few decades. It wasn't until the 1960s that urban designers considered creating spaces for social behaviour or that urban design could lead to anti-social behaviours. These are both now aspects considered when creating a new space (Jacobs 1961, Wall and Waterman 2010). Over time, these changing purposes yield contemporary urban design being primarily concerned with shaping space to encourage the following goals as stated by Wall and Waterman (2010):

- Encourage social activities with the urban space.
- Create positive social interactions.

- Satisfy ecological needs.
- Mitigate negative effects of urbanisation.
- Promote economic growth.

These goals lead to a variety of different principles, defined by Llewelyn-Davies-Yeang and Alan Baxter and Associates (2000), for urban designers to consider:

- *Places for people*: any space to be used must be safe, comfortable, and varied.
- *Enrich the existing*: new development should focus on taking what already exists and improving it, not simply destroying it and creating something from nothing.
- *Make connections*: places need to be easy to navigate and connect to one another and be integrated visually into their landscape.
- *Work with the landscape*: new construction should strike a balance between the man-made and the natural, using each other's strengths.
- *Mix uses and form*: spaces should be able to be used for a variety of different purposes and by a variety of different people.
- *Manage the investment*: places must be economically viable both in the short and long term.
- *Design for change*: new spaces need to be flexible to ensure usability in the future when people and purposes change.

Ultimately urban design is about attempting to create and encourage social practices in an urban space, or as De Botton (2008, p.76) put it *"an impression of the psychological and moral attitudes it supports."*

These goals and principles have a very heavy focus on people: half of them relate specifically to improving space for people and the rest relate to creating spaces that are adaptable and sustainable for future people. As such, this work sees urban design as focussed on the use of physical space to improve people's lives.

Some impressive work has come out of this focus. An example of this is the study into the Levittowners, a two year research project into a planned community named Levittown (Gans 1967). The Levittowners study was a heavy observation- and interview-based research project where Gans (1967) lived with his participants while creating a picture of the social fabric of the town. The results of this study and others throw into doubt the concept of architectural determinism and whether it is as impactful on social life as some believe it to be (Gans 1967, 1994).

Architectural determinism is a theory that the design and implementation of the environment in which people live is a major (or in extremist views of the theory, sole) factor behind a person's behaviour and actions (Craighead and Nemeroff 2002). Whether this is true or not is uncertain but there is some research to back up the concept.

A study into the design of modern (at the time) urban planning of cities by Jacobs (1961) showed how the removal of the *slum* style living arrangement and the creation of large middle-class housing connected by large highways was having a negative impact on cities and the people within. The modern city design was essentially contributing to delinquent behaviour (Jacobs 1961).

Regardless to what degree architectural determinism affects people and how positive or negative the effect the large urban city has on people, urban design is changing and making way for an approach where cars are no longer the primary target of the city. There is now research into ways

to design space to encourage social interaction and walkability (Llewelyn-Davies-Yeang and Alan Baxter and Associates 2000, Gehl 2011). Modern urban design is essentially a lot more focussed on the people side of the goals—and principles presented above—than ever before.

2.5.1 Computing and Urban Design

With such an impressive range of research fields and a very long history as a discipline, urban design would seem a likely candidate to feature a thorough understanding of computing. Alas this is not the case. Despite many of the goals and principles of urban design relating to encouraging social interaction and connecting people to space and to each other, there is remarkably little research into how computing can help with this goal. Indeed, the only instances of using urban design principles and practices in conjunction with computing come from other research fields, such as urban informatics (see Section 2.7.3 for more detail).

Bilandzic (2013b) investigated a library space which was architecturally designed to encourage collaboration amongst the people within. Following architectural principles of creating a place from a space as the theoretical backing, the results of a five month ethnographic study uncovered several reasons why the space was not working as intended. From this two different interventions were introduced, one social and the other a computing device, both intended to encourage more social interaction amongst the people in the space (Bilandzic 2013a, Bilandzic, Schroeter and Foth 2013, Bilandzic and Foth 2014).

Another urban informatics project put large screens in various public spaces during different public events and showed SMS and tweet messages that people were sending to the public display (Schroeter, Foth and Satchell 2012). The intent behind the project was to uncover what barri-

ers prevent people from engaging with public displays. The study uncovered that there is a sweet spot of engagement with the screens, where high quality messages were being posted at a rate that kept people interested (Schroeter et al. 2012).

In both projects the importance of the place and the people within had to be considered and kept at the forefront when adding technology into the place. Indeed in both studies the importance was paramount, with the first study study using the architectural understanding of place by Ruskin (1885), Lawson (2007) and De Botton (2008) (amongst others), and the other using the elements of engagement framework by Dalsgaard, Dindler and Halskov (2011). These two are not the only projects in urban informatics to use urban design principles in their work but are typical in that they do indicate that urban design principles are remarkably adaptable and applicable to what is otherwise an unconnected field: computing.

2.5.2 Summary

This section has discussed urban design, the field of research concerned with the design of space for the betterment of people. Urban design has many different research fields encapsulated within its banner and has produced research offering insight into the best ways to design space to help encourage a place to emerge.

Urban design unfortunately does not offer a great deal of insight into how computing impacts or is impacted by space; the field is very much rooted in its past of building physical spaces for specific purposes. The bulk of the work investigating computing in these spaces has been undertaken in another discipline: urban informatics. The research in this field, however, does show great opportunity in better connecting technology to space.

2.6 The Third Place

The Third Place (also called a great good place) is a term popularised by Oldenburg and Brissett (1982) to describe places which exist, as the name implies, as the third place where people go to spend their time outside of work and home. The third place is a social space, designed to sit between people's most common social spaces: their home and their work. These spaces are intentionally social and they act as *anchors* for a person's community, allowing the people who frequent them to discuss matters outside of the range of normally allowed topics at their other two places (Oldenburg and Brissett 1982).

The key characteristic of a third place is sociability. The places have to allow and encourage people to be sociable with one another, especially without any pre-existing social hierarchy preventing people from engaging with one another (Oldenburg and Brissett 1982). Over time, much like with any theory describing social phenomena, the various different studies into third places have resulted in a collection of properties to help understand and describe what makes a third place. The following properties come from Myers (2012) and Quandt and Kröger (2013):

- *Neutral ground*: people are free to come and go as they please and people in general will bring or leave issues with people into or out of the place.
- *Leveler*: a person's social, financial, or other status is irrelevant to the place. People do not need to meet any requirements to be a part of the place.
- *Conversation is the main activity*: although a place may have a listed or specific purpose, the reason people come is for the conversation.

- *Accessible*: tying into the first two properties, the place requires no great effort to frequent.
- *The regulars*: these places will often have a gaggle of regular participants who help define the mood of the place.
- *A low profile*: tying back into the accessibility of the place, third places will have very little pretence around them; they will be welcoming and informal.
- *The mood is playful*: the mood of the place will generally be frivolous and playful, focussing on banter and chit-chat.
- *A home away from home*: a third place will be somewhere its members will feel at ease and a place over which they feel some level of ownership.

These properties help researchers to understand if a space is or is not a third place or to what degree a place is like a third place.

The theory has had a rather large amount of investigation, from criticism about the concept itself (Putnam 2001), to applying it solely to virtual domains (Steinkuehler and Williams 2006), and even workshops devoted to technology in third places (Hacking HCI3P 2014). The majority of the work in integrating technology into the third place has focussed on using the third place to help structure thoughts and design, to help explain a (often virtual) space (Wadley, Gibbs, Hew and Graham 2003, Steinkuehler and Williams 2006), or to provide insight into new and emerging digital communities (Fortin, Hennessy and Neustaedter 2014). Other projects have investigated the impacts community 'hacking' has had on third places (Cheverst, Taylor and Do 2014). Some previous work using computing technology and the third place includes using augmented

clothing to encourage and control social interactions, thereby allowing clothing to be used as a mediator of a third place (Fraser and Doyle 2014). Other research projects have investigated design frameworks for the third place to better allow future researchers to build and integrate public displays into third places (Calderon, Fels and Anacleto 2014).

2.6.1 Third Place and This Work

Despite the large amount of research involving third places and what appears to be an obvious overlap, there appears to be little or no work in trying to combine the disparate theories of information grounds and the third place. A third place is by the above properties easily captured within the many properties that the PPI trichotomy offers as a means of explaining them. Indeed the only property which is not neatly explained as immediately obvious as fitting underneath the information grounds banner is that of *conversation is the main activity*.

An information ground is by its nature something created when people go to a place for a purpose other than conversation but from which conversation arises. It could be argued that despite conversation being a main activity at a third place it is not the reason why people attend them (see Section 2.4.1). It could also be reasoned that information grounds do have conversation as a main activity and the purpose is just a catalyst being used by people as their justification to go to the place where conversation will occur. Either way there are definite similarities between the two places.

The third place also fails to account for the spaces where the difference in position and purpose does impact the space, such as waiting staff at a pub or buskers at a park. Information grounds can however encapsulate places that a third place cannot, such as hostage information grounds where the person does not want to be there but has no choice. Unlike in-

formation grounds, there has been a great deal more research into how technology and third places interact with one another. Much like with information grounds, however, this is in many ways an afterthought or the third place theory is being used to help structure thought in a virtual or online space.

Ultimately the third place, while offering some insights into how people and a space can interact, does not offer insight into mobile technologies in these places and its very nature of being a home-away-from-home excludes it from being applicable to many communal public spaces, especially outdoor markets. Third places are by their nature small, this allows for the regulars to form, whereas the outdoor markets are very large and have huge numbers of participants. The third place also has the principle of conversation as a primary purpose, whereas the outdoor markets again, do not.

2.7 Active Fields

The previous sections have looked at the different fields of study that have mostly taken a passive approach to exploring public space, that is to say they have preferred to focus on understanding instead of changing. This section will look at the fields which take the other approach: a focus on introducing a change to a place over gaining an understanding. It is worth restating that neither approach is better than the other; each has its own strengths and weaknesses depending on the goals of the particular project.

The different research fields which comprise this section loosely fall under the banner of Human-Computer-Interaction (HCI), a discipline focussed on exploring what and how computers and humans interact with and affect one another. This is a somewhat contentious statement and

many of these fields would say HCI falls under their banner rather than the other way around. Regardless this approximation is sufficient for this work. The different fields that will be discussed in this section are as follows:

- Ubiquitous Computing and Awareness will discuss the research performed in the Ubiquitous Computing and Awareness Systems research, covering all forms of awareness research.
- Computing Supported Cooperative Work (CSCW; sometimes also listed as Collaborative), will cover the research around space from the CSCW field.
- Urban Informatics will discuss the research performed around space from the urban informatics research discipline.

All these fields are heavily interconnected and what one researcher would call an Awareness system another may feel fits better in CSCW or belongs more to the Urban Informatics branch. Due to this the below sections are as much for readability as they are for correctness.

2.7.1 Ubiquitous Computing and Awareness

Ubiquitous computing (also referred to as ubicomp) came about from Weiser's (1991) work into novel user interfaces and interaction in the 1980s. The basic idea of ubiquitous computing is that computing technology will become more advanced and more integrated into our lives so that we will use it without explicitly thinking about how or what we are doing; computing technology will become second nature.

"The most profound technologies are those that disappear. They weave

themselves into the fabric of everyday life until they are indistinguishable from it."

Weiser (1991, p.3)

The dream of ubiquitous computing is to have systems that are invisible and with which we interact without even thinking about them. Related to, and seen as an important component of ubiquitous computing systems, is calm computing. Calm computing is the concept that technology should be passive and undemanding of a person's time and attention, technology that *"is informing without overburdening"* (Weiser and Brown 1996, p.76).

An interesting issue here is that in order to do this the systems need to have an understanding of the context of an action. That is the information and current situation that is used to help inform the action. Without such an understanding, any information generated or actions performed may well not be appropriate, causing the user to intervene and destroying the illusion of the technology hiding in the background. Therefore a definition of context needs to exist. This is an issue with which computing researchers have struggled for some time, Every researcher, when talking about context, tends to create their own definition of context. These definitions often are just synonyms for context (Dey 2001, p.7). This research uses the following definition of context for the remainder of the work:

"Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Dey (2001)

A major component powering ubiquitous computing is awareness systems. These are computing devices and software which provide an in-

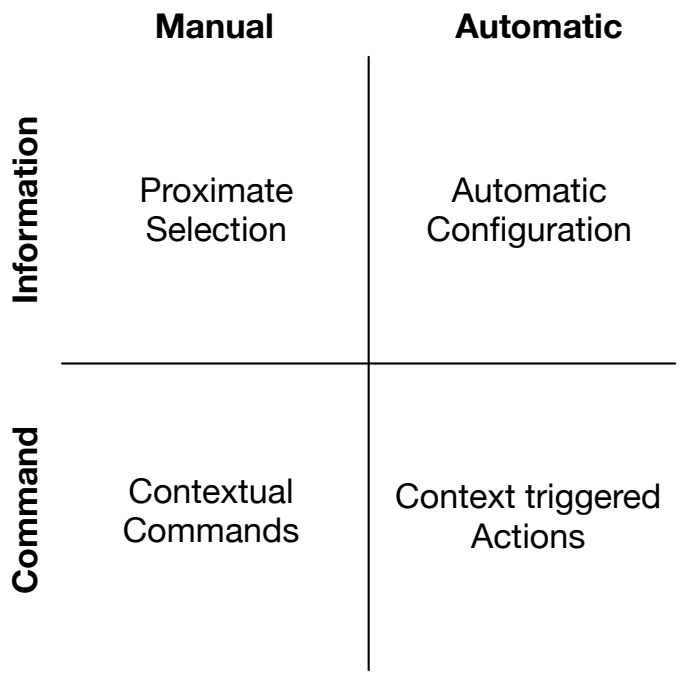
sight into the behaviours, actions, and context of another person or the participant themself (Dourish and Bellotti 1992, Schilit et al. 1994, Chen and Kotz 2000, Dey 2001). As with most computing research, this general idea of having an insight into the context of a person is not precise enough. Awareness systems are therefore generally broken up into three different categories:

- *Location awareness*: Systems which use location as the primary context source.
- *Context awareness*: A general catch-all for any system which uses context sources.
- *Social awareness*: Systems which are designed to give a person an insight into people other than themself.

Of these three categories location awareness is the most explored, most likely due to the relative ease of determining location via technological means. All three categories heavily overlap and it is mostly up to the researcher to decide into which category they feel their work falls. These three categories essentially just differentiate the goal and sources of context used to provide the awareness. Awareness systems are also broken up into what they do with any appropriate context they determine or are provided.

Schilit et al. (1994) decomposed the possible features an aware device could take into two dimensions: whether the task is getting information or running a command, and whether the the task should be performed manually (by the user of the system) or automatically by the system itself.

Table 2.1: The awareness task breakdown. Reproduction from Schilit et al. (1994)



Proximate selection relates to the idea that contextually *close* items and actions are emphasised more in the system interface than others, making it easier to perform these actions (Schilit et al. 1994). Automatic configuration is where the system connects and changes what the system can do depending on the context, such as connecting to other machines to use their resources instead of slowing down the user's work (Schilit et al. 1994). Contextual commands exploit the concept that many possible actions can be predicted by a person's context and then make these options available in that context, an example is defaulting to the printer in a user's room when they print a document (Schilit et al. 1994). Finally, context triggered actions are actions that the system will automatically trigger and perform once the correct contextual position occurs (Schilit et al. 1994).

Dey (2001) on the other hand split awareness features into three categories:

- *Presentation*: Systems which present information and services to the user.
- *Automatic execution*: Systems which automatically perform actions for the user.
- *Tagging*: Systems which tag context information for later retrieval.

This work, however, considers the work of Chen and Kotz (2000) to be the most apt and useful: *active* systems, those systems which automatically adapt and change based on the context, and *passive* systems, those that record and present updated context information letting the user decide what they wish to do. This work prefers this definition over the others because it is immediately understandable: there are some systems which show context and others that perform actions based upon it. This is not to say that the definitions by Schilit et al. (1994) and Dey (2001) are deficient, just that this work prefers Chen and Kotz's (2000). The active and passive breakdown is also remarkably similar to that created by one of the earlier works to look at awareness by Dourish and Bellotti (1992) where they defined the types as *explicitly generated* and *passively collected*.

For a truly ubiquitous computing future we will require both active and passive systems, however, this research takes the approach that for the immediate time-being passive systems will provide better results than active. The reasons for this are simple: people are complicated and for a system always to perform the correct action it needs to have a through understanding of the context of its user. A passive system allows for the user to determine what to do based on the context, allowing researchers

and developers to exploit the innate intelligence of a person instead of trying to guess their intent correctly. The trick is providing the contextual information in a way that is meaningful to a person.

2.7.2 Computing Supported Cooperative Work

CSCW is a field devoted to supporting people to collaboratively work together more effectively. The field began with a heavy focus on supporting office workers through what was coined Groupware, effectively breaking activities into a two dimensional matrix known as the CSCW matrix, shown in Table 2.2, (Johansen 1988).

Table 2.2: The CSCW Matrix. Reproduction from Johansen (1988)

	Same Time	**Different Time**
Same Place	Face-to-Face	Continuous Tasks
Different Place	Remote Interactions	Communication & Coordination

The matrix breaks CSCW into four different context situations to be considered and how best these can be supported. These are:

- Face-to-face.
- Continuous tasks.
- Remote interaction.
- Communication and coordination.

As a field CSCW has long since expanded beyond work and groupware to include collaborative play and learning, as well as general shared social experiences under its banner. The basic problems of what is important depending on the context and the best means to share it have not changed. In effect the idea behind CSCW is remarkably similar to that of ubiquitous computing and awareness systems; determining what contextual information is relevant and sharing that to make people's live and current activities better.

As was the case with ubiquitous computing (section 2.7.1), any system that truly wishes to encompass and enhance a communal public space will need to consider all context situations. This work takes the approach that the remote interactions and communication and coordination interactions are those that will provide the greatest impact upon the space. The reason for these two are because they are the interactions that work best with passive systems (discussed in section 2.7.1). People already have an understanding of context when they are physically and temporally co-located and will therefore need less support in the face-to-face interactions that a communal public space offers. Additionally, and for related reasons, when people are physically and temporally distant in a communal public space they have the least amount of shared context so it offers a great opportunity to explore the impact such a system would have, should one be warranted.

2.7.3 Urban Informatics

Urban informatics is slightly different from the other active focussed research fields presented here. Unlike the others it generally is not self-identifying as a computing field but a cross-discipline one (Foth 2009). Urban informatics borrows from a variety of fields including ethnography, art, computing, and urban design (Foth 2009). Secondly, urban informatics is younger than the other fields and has benefited from their researcher's experience. It takes a much more holistic approach to a space, fully exploring and attempting to understand it before introducing any change. Urban informatics researchers were able to learn from the issues the other active fields encountered before it was born, giving it a much wider lens with which to view the world.

Urban informatics also has a different focus than either of the other active fields: it is interested in *"how ubicomp artefacts can enhance the communicative ecologies"* (Bilandzic and Venable 2011, p.2) and is heavily tied to the concept of the *"real-time city"* (Foth 2009, p.XXIII). Communicative ecologies are both a model for understanding and presenting the relationships between the three different aspects of communication—offline and online, global and local, and collective and networked (Foth and Hearn 2007)—and the concept itself of how people communicate in communities.

Each of these aspects form a dimension in which people's communication can be plotted, creating a three dimensional mapping of how people are using and participating in communication with others. The intent is that any insight from this mapping can be used to help enhance or create an ecology that is more appropriate for the people intended to make use of it (Tacchi 2006).

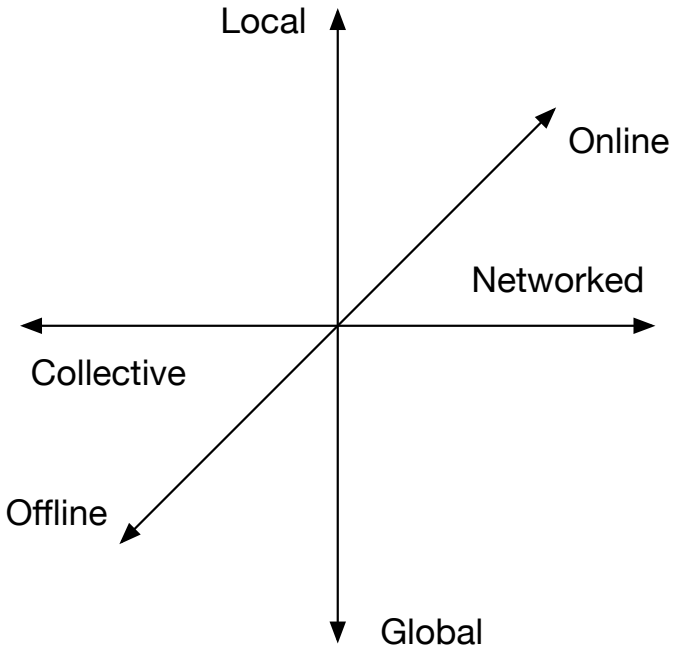


Figure 2.3: The Communicative Ecologies Map. Reproduction from Foth and Hearn (2007)

The real-time city is the inevitable expansion of the communicative ecology idea: taking communities and how they communicate and applying it to an entire city. A real-time city will enable one to *see* a city in new ways. With a heavy use of embedded sensors and output technology (such as public displays) the city can be shown as alive and changing. This allows new models and insight to be gained, providing developers new opportunities to enhance people's lives (Foth 2009).

With such a holistic approach to places, urban informatics may seem that it perhaps fits better with the passive fields instead of with the rest of the active. Urban informatics is, however, still very much part of the active field of research, and uses a great deal of the HCI and ubiquitous computing research to help form any changes that they might wish to introduce.

Interestingly, urban informatics also promotes the idea of social intervention as well as the technological, something none of the other active fields do to any large degree (Foth and Hearn 2007, Bilandzic 2013a).

In most respects the work presented here falls neatly into the urban informatics bucket. Both urban informatics and this work are heavily concerned with examining how technology impacts people and space, and both are heavily interested in understanding a place before introducing any change.

The only significant difference is that of the final goal of the work. Urban informatics is focussed primarily on communicative ecologies; it is trying to build a new and better world using pieces of the old. This work, however, is concerned more about the present and is content with only improving the world as it currently exists. Urban informatics is trying to create a revolution in urban spaces using the old world as the starting point. This work is simply trying instead to evolve the current world, adding to it without significantly changing it. It takes an approach more in line with McCullough (2005) view of ubiquitous computing, changing the fabric of a place and not replacing the fabric.

The next section will investigate and discuss some of the previous research performed within the fields recently discussed in Sections 2.7.1 to 2.7.3, Ubicomp, CSCW, and Urban Informatics.

2.8 Past Research

This section will discuss some of the previous research that has been performed in the fields of Ubiquitous Computing, CSCW, Awareness Systems, and Urban Informatics (see Sections 2.7.1 to 2.7.3 for details). The literature is too broad to repeat on all projects. Instead those seminal projects

relating directly to the work undertaken here are described. Specifically, as this work is focussed on communal public spaces and outdoor markets specifically as an example of the aforementioned, past research projects which have investigated this or similar areas will be the focus of this section.

2.8.1 Mixed reality museum

Brown, MacColl, Chalmers, Galani, Randell and Steed (2003) performed a study into what they called mixed reality co-visiting of a museum–integrating physical, virtual, and web through an online tour–attempting to allow museum visitors to better share the experience as a group. The system they built provided three different sources of awareness to facilitate this shared experience: an audio channel, location and orientation, and a shared information space (implemented as being able to become aware of what exhibit the other group members are viewing).

The physical visitors had a portable digital assistant device (PDA) to allow them to communicate with and see what the rest of the group was doing. A 3D virtual world arranged to mimic the museum was presented with the rest of the group appearing as avatars in that virtual world. Finally, the web visitor had a website showing where the rest of the group members were and also the museum exhibits themselves. All visitors had audio headsets to keep in audio contact with one another.

A study into the system found that there was little barrier to the visitors remaining in contact with each other; the audio channel did an adequate enough job (Brown et al. 2003). They did uncover issues, however, with navigation relative to each other, with the physical or web visitor generally being required to navigate the virtual visitor to be with the group (Brown et al. 2003). The study also found that the visitors were able to navigate

using each other as points of reference or making use of a combination of the map and the audio channel to do so (Brown et al. 2003). There were issues with such as terms as "left" or "forward" having little to no meaning depending on which type of visitor the participant was (Brown et al. 2003). Overall the study found that despite many issues, people were able to adapt to and use the system. The researchers found that augmenting location with both orientations, the audio channel, and placing additional useful information onto a map had the potential to improve the experience of co-visiting a museum (Brown et al. 2003).

2.8.2 ActiveCampus

The ActiveCampus research was exploring ways in which CSCW technologies can enrich the learning community at a university, and focussed on two sub-projects: the ActiveClass and the ActiveCampus Explorer (Griswold, Shanahan, Brown, Boyer, Ratto, Shapiro and Truong 2004). The ActiveClass tool allowed students with a PDA to anonymously ask questions, to answer polls, and to provide feedback during a lecture. The focus of ActiveClass was very heavily on the dyadic professor-student relationship in its initial phases but it was modified to allow students to answer student questions, increasing the cross-chatter within the place.

The professor involved in the study considered the classes' levels of engagement to be quite high compared to when they did not have the tool (Griswold et al. 2004). The ActiveClass is in many ways similar to the Slam system (see Section 2.4.4) in how it works and how it was used by their respective participants. As with Slam, this work doesn't consider the ActiveClass tool to be supporting an information ground (and for the same reason, people are in the place for the primary goal of gaining information) but it does still show a desire to gain more information and a willingness

to use technology to do so in situations similar to information grounds.

The other component of the ActiveCampus research was the Explorer tool. This was a location awareness program designed to give its users a form of x-ray vision, allowing them to see through crowds and buildings to locate their friends, classmates, lecturers or events, to which people could then communicate via messages. This also was implemented through a PDA application displaying a map of the university campus–including the locations of the above shown on it as well as the user's current location–and a listing of the above with descriptive terms such as "nearby" to indicate proximity. Despite a host of issues related to the implementation of the ActiveCampus Explorer, such as the device battery only lasting for four hours, the program did garner some interesting findings (Griswold et al. 2004).

There was an assumption about relative location not being particularly important. This was shown not to be the case, with the majority of communication occurring when people were within 50 feet of each other and showing a huge link between being co-located and wanting to communicate. Another interesting finding was the desire, or lack thereof, for privacy. The majority of the participants shared their location to friends. Over eight percent shared their location to everyone, and only one percent of users refused to share location at all (Griswold et al. 2004). When these results are taken together it shows a desire to be together and once we are together to share information with one another.

2.8.3 Place Mediators

Some systems have been created with the express goal of attempting to encourage people to connect more in a digital sense to one another, or have had this occur by emergence when the users appropriated the system as the

project continued. This work refers to these projects as *place mediators*.

Surfing in the Crowd by Lee, Cheng, Yeh, Chen, Yu and Chen (2008) was an experiment to see whether social-proximity applications (that is applications that perform or enable social interaction once a certain proximity is reached) could be used to share in-situ experiences of a night marketplace in Taiwan. The implementation of this concept was a smartphone application using bluetooth to limit the proximity of the social-proximity application to a few metres. Within this range, any person using the application would have their photos of the market shared to the other participants of the system (Lee et al. 2008).

As people were walking and intermingling in the market environment, new photos appear and disappear as the crowd moved and changed. An evaluation of the system found that people were using the shared photos as a catalyst for social interaction, with groups of friends looking at photos taken by others nearby and trying to find the stall or to discuss what they were all looking at (Lee et al. 2008). This use of photos to begin a conversation shares similarities to the Pink banner being used to mediate an information ground in Section 2.4.4. Both are using a technological means to encourage a place to emerge (or become more prominent).

Similar to the Surfing in the Crowd research there have been many different uses of computing technology to mediate or create a conversation.

MobiTag was a semantic, spatial, and social navigation tool for museums allowing researchers to see how participants were using these three different means of navigation for later optimisation (Cosley, Baxter, Lee, Alson, Nomura, Adams, Sarabu and Gay 2009). The researchers discovered that the participants were exploring and digitally tagging exhibits at the museum (Cosley et al. 2009), reflecting past research that show people will engage with museum information (Trant, Bearman and Chun 2007)

even when they act differently around exhibits in the physical world (Gay 2004). The use of tags in MobiTag was varied but the tags were being used to create a sense of other people's presence in the museum, to connect to them on some level even when they were not physically in the same space any longer (Cosley et al. 2009).

The use of leaving information behind to help to create or mediate a place was also a component of the GUIDE system for tourism in the United Kingdom (Cheverst, Mitchell, Davies and Smith 2000, Cheverst, Smith, Mitchell, Friday and Davies 2001). It was intended that by leaving behind information, tourists using the system would be able to create a sense of a shared experience and increase cooperation amongst the otherwise isolated tourists (Cheverst et al. 2000). These systems show that people are willing and able to use technology to mediate a place, even over a physically distant space or if they are temporally disparate from each other.

2.8.4 Location, Location, Location

ReGroup by Nugent and Lueg (2010) was a mobile phone application designed to increase social awareness and aid in informal planning amongst a group of people. The application showed the current and immediately prior locations of its users as a coloured line overlaid onto a map, with each user getting their own line in the application. The application also allowed users to leave messages for each other. These messages would appear as annotations on the map at the point where they had been left.

The participants in the research were taken to a local outdoor market and given a simple scenario to accomplish (Nugent and Lueg 2010). The researchers found that despite some issues (relating to the layout of the market and some software issues), the participants were able to use the application to diverge and merge back together as a group without an explicit

need to communicate. The participants also appreciated the application's features and were positive about future versions of the software. Despite being only a short-term study, the participants showed early stages of appropriating the application for their own need, particularly the message annotation system (Nugent and Lueg 2010).

ReGroup relied heavily on location as the primary context, a very common approach as discussed in Section 2.7.1. Because of this, location is a very heavily explored source of context in situations and ground breaking has come about from determining, showing, and sharing location.

One such project was iSocialize, which used location amongst other awareness sources (activity, status, and relation) to investigate what awareness cues are important to people (Andersen, Jørgensen, Kold and Skov 2006).

A laboratory study of the system uncovered a variety of issues around using awareness cues on a mobile device. Of particular interest was the finding that for the awareness cues (including location and activity) to make sense and be useful by others, there needed to be a pre-established connection amongst the sharing participants. Without this shared social context people were unable to give any meaning to the location aspects of the prototype system (Andersen et al. 2006).

Similar to iSocialise was Connecto by Barkhuus, Brown, Bell, Sherwood, Hall and Chalmers (2008), another social locative awareness application. In this project, rather than sending around multiple awareness sources, Connecto only shared two sources: automatically determined location (although it could be manually set by the participants), and the phone's current ringing status (such as silent or vibrate) (Barkhuus et al. 2008). Unlike iSocialize, Connecto was evaluated by groups of close-knit people who already had established their social networks.

The results of the evaluation of Connecto showed some very interesting results. The system was popular with the participants and it did not exhibit the same empty information problem that iSocialize had (Barkhuus et al. 2008). The participants also set activities interchangeably with location. Someone may set a location as *pub* or *economics lecture* and not only was this understood by the other participants but in some cases was used by participants as invitations for others to join them (Barkhuus et al. 2008).

From this work we have learned that location can be used to encourage social interaction in a physical space. Of particular interest to this work are the results showing that for a meaningful connection to be established the people involved must already know each other.

2.8.5 Screens and Space

As was mentioned briefly in Section 2.5.1, some work has focussed on how the addition of interactive public displays can be added to a space to impact it in some fashion. Interactive public displays are systems which have one or more large public screen and a means for people to interact with them in some manner. Public displays have shown a great deal of potential and have been used successfully to increase the social interaction amongst co-workers in work environments (Churchill, Nelson, Denoue, Helfman and Murphy 2004, Huang, Russell and Sue 2004, McCarthy, Congleton and Harper 2008) as well as showing some success in creating attachment to places in non-work environments (McCarthy, Farnham, Patel, Ahuja, Norman, Hazlewood and Lind 2009). This shares similarities to the work done by Counts and Fisher investigating purely digital information grounds discussed in Section 2.4.4, which looked at how technology can be introduced to create a place. In the case of the interactive public displays the places were arguably already established and the displays gave it something to

coalesce around, but both do show technological artefacts can impact a space from a social perspective.

One system of particular interest to this work is the Discussions in Space public display project, which was an interactive public display designed to increase social engagement on issues affecting the city of Brisbane (Schroeter 2012). The system was intentionally simple, issues were displayed on the screen and people could either SMS or tweet their comments on the issues. Comments were moderated and then posted on the screen as speech bubbles, the intent being to create a conversation around the issues.

The work discovered a great deal about getting people who would normally not engage in civic issues to participate in the interactive display, especially around the low barrier to entry of SMS or twitter. Different groups of participants were identified; contributors, trolls, clown, social players, and passive or non-users. The users who were not actively engaging with the system still felt a sense of attachment to the system and enjoyed that it was there. Much like the earlier work into public displays, Discussions in Space also helped to create a stronger sense of community amongst the people that made use of the project.

From this and related interactive public display work we have learned that public displays can be introduced into a space to help create a stronger sense of community and social interaction and that there are many different levels of user interaction with a system. Of particular interest to this work are the results that supporting passive or non-engaging users is worthwhile and important to the system as a whole.

2.8.6 Theory and Practice

Much of the work presented so far has used or created theory out of the research, preferring to focus on the *implications for design* approach. This

approach distills the work down into design implications and guidelines for future researchers. It has been criticised as missing out on the benefit that can be gained by not distilling the research down (Dourish 2006a). This does not mean that the implications for design are not useful, simply that there is more out there. This section will look at research which has used or created more theory from their work than design implications.

Similar to the work from Section 2.8.4 which investigated the use of location sharing to encourage social interaction, Kjeldskov and Paay (2005) investigated co-located social interaction in the Just-For-Us prototype system. One of the features of Just-For-Us was the ability to display areas of high sociality as coloured circles overlaid on a map. The colour of the circle indicated activity, such as *"having coffee"* and the size indicated how many people were at that area (Kjeldskov and Paay 2005).

The research began by using the McCullough (2005) *"on-the-town"* typology of interactions in place to explore the everyday interactions at Federation Square in Melbourne (Paay and Kjeldskov 2008). The results of this were used in conjunction with two approaches–PIA (Physical Interaction Abstraction) and SOPHIA (SOcial PHysical Interaction Analysis) to design and develop the prototype application (Paay, Kjeldskov, Howard and Dave 2009).

The PIA approach led to drawing a map of the space annotated with information showing where and what was occurring, allowing the researchers to see the hot spots of interaction in the space (Paay et al. 2009). Additionally, a matrix was created showing specific types of design appropriate ideas, allowing for the design concepts to be tied back to a physical space. The purpose and goal was to see if PIA could capture and easily present inhabited physical context (Paay et al. 2009).

SOPHIA on the hand attempted to capture a hierarchical breakdown

of the social context of the space. Much like with PIA the results were mapped to a matrix of design ideas to information gathered. The key areas identified were as follows:

- Knowledge of the space.
- Historical knowledge.
- Situation amongst people.
- Situation amongst place.
- Situation amongst space.
- Sense making.
- Movement intentions.

With PIA and SOPHIA completed, the researchers then were able to focus on their intangible goal of *"enriching people's experience of Federation Square"* (Paay et al. 2009, p.19). The result of this was the aforementioned mobile prototype, Just-For-Us.

An initial researcher evaluation of the system at the busy Federation Square in Melbourne revealed that when people are attending the space as a group they rarely navigate around such busy environments using maps or by following route instructions (Kjeldskov and Paay 2005). The participant evaluation showed amongst other results, that people explore the space as a series of connected nodes, using the spacial edges to orient and move through Federation Square (Paay et al. 2009). Of particular interest to this work was the participants' interest in being able to gain insight into what the other people in their group were doing through the application (Paay et al. 2009), a finding that was mirrored by the later Connecto research (Barkhuus et al. 2008).

Out of the results came the Socio-Physically Informed Development Process, a new development approach for ubiquitous computing in urban environment (Paay et al. 2009). The Socio-Physically Informed Development Process can be seen in Figure 2.4.

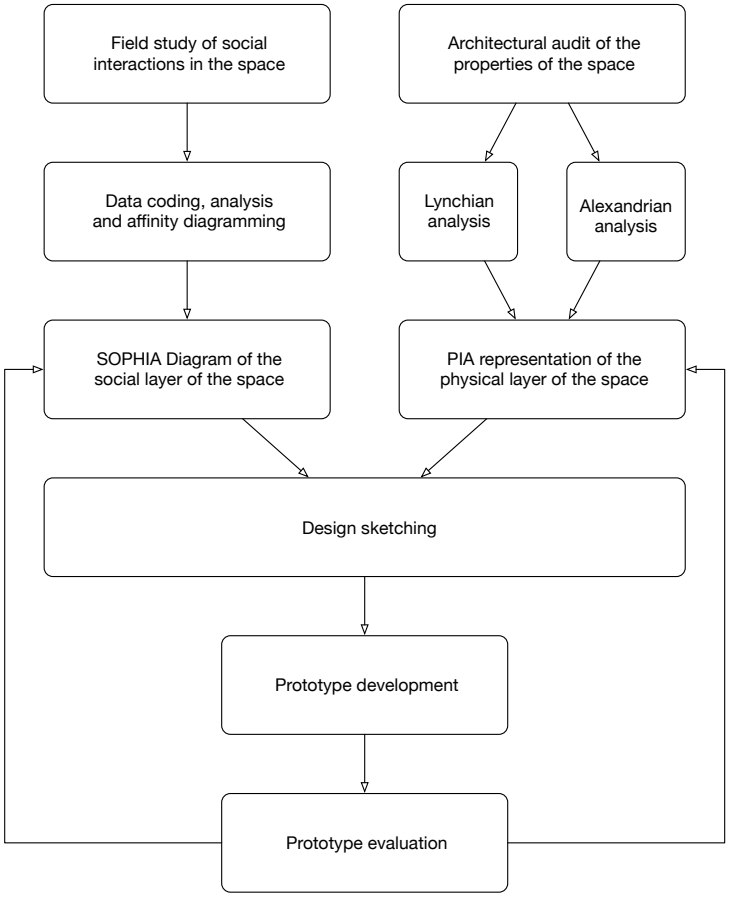


Figure 2.4: Socio-Physically Informed Development Process. Reproduction from Paay et al. (2009)

Another attempt at creating theory from research is that of P3 systems, software systems which tie People-to-People-to-Place[2] (Jones et al. 2004). An analysis of many different location based systems revealed that they

[2]Place in this context relates more to what this work is calling Space.

were focussed very heavily on connecting people together and then connecting the people together in a shared space (Jones et al. 2004).

Table 2.3: The P3 Framework. Reproduction from Jones et al. (2004)

	Synchronous	**Asynchronous**
People-Centered	Provides remote awareness	Provides location history
Place-Centered	Provides spatial interactions	Provides knowledge about past use

Many different research projects and systems were examined and the P3 systems framework was born. The framework divided social locative applications into a two-by-two matrix: People or Place centric and Synchronous or Asynchronous (Jones et al. 2004), see Table 2.3. These were then subdivided into additional subcategories. The results from the P3 framework allowed researchers to see where their work falls into the framework, allowing it to be compared easily to other systems (Jones et al. 2004). While the P3 systems framework is mostly a descriptive one, by allowing people to categorise and compare systems it can also be used to help design them (Wittison and Lueg 2013).

2.8.7 Summary

The active fields of research have created some amazing results around using computing technology in space. This section had a strong focus on the use of context especially location due to its prominence in the fields to help give people an insight into the actions and context of themself and others.

Previous research in the active fields has shown that context information can be used to help a person feel more tied to a space as well as be used to mediate and create a place where one either did not exist or was nascent. Context has also been used to link people together, with computing technology being used to let people connect more easily when physically separate. Past work also shows that people do need to be part of a pre-existing social group to gain the most benefit from any any context awareness system.

Interestingly, most of this work is old by computing standards. The bulk of the work was completed by 2009 and little of it was followed up. Ideas were created, concepts explored, and design implications and theories brought to life only to then be left behind. Some of the work discussed here led to products in use in the modern computing world—particularly in location sharing applications and tagging—but the majority of the work just ended. This is problem referred to as the research-practice gap (Sutcliffe 2000, Norman 2010).

This section has also shown that the majority of the research has been devoted to introducing computing technology for what is little more than technology's sake, to just see what the impact is. Far less work has begun with a theoretical underpinning or aimed to create useful theoretical contributions once complete.

Finally, this section has only skimmed the surface of what is available, focussing on research which has the most direct impact on this work. There is more available (even in fields as young as these). For example there is work on systems to tap into local knowledge (Bilandzic, Foth and De Luca 2008), building products to encourage people to connect at co-working spaces (Bilandzic et al. 2013), attempting to create partnerships between the community and government (Foth and Adkins 2006), offering understanding of the importance of mobile connectivity to people today (Satchell 2008), using non-visual alerts for knowing when friends are nearby (Holmquist, Falk and Wigström 1999), encouraging interaction at conferences (Borovoy, Martin, Resnick and Silverman 1998, Borovoy, Martin, Vemuri, Resnick, Silverman and Hancock 1998), and bridging online and offline social networks (Kostakos and O'Neill 2008). Those reported on in detail are those with the greatest relevance to the work of this thesis.

2.9 Insights from the Past

Using the understanding of the many different aspects of public space and computing technology from previous sections, is to identify the trends in the literature and to identify any gaps and omissions as well as to critically discuss the implications of the literature on this work. The remainder of this chapter is structured as follows:

- Section 2.9.1 identifies the prominent trends in the literature.
- Section 2.9.2 explores the omissions and gaps in the previous work.
- Section 2.9.3 discusses, summarises, and concludes the work before closing the chapter by introducing the next stage of the thesis.

2.9.1 Trends

There are a number of ongoing trends which can be identified from the literature around the understanding of public spaces and the use, design, and development of computing technology within public spaces. The most significant trends identified in the review of the literature are:

- The passive fields rarely explore the role of computing technology in public spaces.
- The passive fields are moving toward acknowledging that computing technology plays a part in the places.
- The active fields rarely make use of theoretical underpinnings before beginning research.
- The active fields rarely provide theoretical contributions, preferring design implications and guideline construction, although this is changing.
- Shared context is mostly useful only to preexisting social groups.
- Displaying context can make a person feel more tied to a space.
- Little of the the research into computing has made its way to the general public.
- Little of the research investigating mobile computing in public spaces is recent.

2.9.2 Gaps and Omissions

Section 1.2 put forth a premise: *that there is an insufficient understanding into how technology can support communal public spaces.* This premise was ex-

plored in this chapter, and in combination with the aforementioned trends led to the development of a number of observations about the research premise:

- There is a lack of research and understanding into how people, space, and mobile technology interact.
- There is a lack of research into how mobile technology can support people's activities and goals inside public space.
- Public spaces are poorly understood from a design perspective. There is no framework specifically for understanding public space from a mobile technology perspective only a myriad of different related topics.

2.9.3 Conclusion

The review of the literature presented throughout this chapter has focussed heavily on the use of computing technology and public spaces. The review began by breaking up the existing literature into two main focal points, the passive and active fields.

The passive fields contained research with an approach focussing on gaining understanding and insight into how the public space operated and included research from Information Grounds (discussed in Section 2.4) and Urban Design (discussed in Section 2.5). These fields provide a great deal of insight into how public spaces are created, how they operate, and what people do when they are participating in them. Unfortunately these fields also fail to provide insights into the role that computing technology plays in these places.

The active fields (discussed in Section 2.7) also cover a wide array of disciplines and research projects, including ubiquitous computing, CSCW,

and urban informatics. These fields offer a great deal of insight into how computing technology can tie people to space and enable people connect to one another through sharing contextual information. Unfortunately these fields—with their focus on doing—offer little theoretical insight into how the people and space work together with computing. The focus is nearly always on creating a new system and observing its impact.

The next step for this work then is to plan how to rectify these omissions, Chapter 3 investigates what approach to use to fill the gaps in the literature. There are two options to take this work going forward, matching the two theoretical frameworks with a goal of informing system design in public spaces were uncovered: the People-Place-Information trichotomy (Section 2.4.3), and the Socio-Physically Informed Development Process (Section 2.8.6). Both place a focus on the space and the people inside of it. This work will be using the People-Place-Information trichotomy as it continues ahead. This is due to the PIA component of the Socio-Physically Informed Development Process, with its focus on the spatial elements (such as landmarks and paths) of the public space. This research takes the approach that due to the previously identified restrictive nature of outdoor market (Nugent and Lueg 2010) such a focus would be wasted.

3

Methodological Approach

This chapter discusses the approach, tools, and philosophies available to guide the research design and implementation. The Participatory-Action-Design-Research approach from the Urban Informatics field is chosen as the approach this work will use. The chapter finishes by discussing the specific implementation details of the Participatory-Action-Design-Research approach of this work.

3.1 Introduction

As discussed in Chapter 2, this work is under an umbrella of a variety of related research fields and disciplines. As such, previous research in the many fields have taken several different approaches to collecting and interpreting knowledge and the precise means of doing so have changed depending on the goals and internal philosophies of the research and its researchers. This chapter will discuss the various means of acquiring and understanding knowledge previously used in the related fields, and also present the philosophy and techniques this research will be using.

3.1.1 Chapter Structure

The remainder of the chapter is as follows:

- Section 3.2 discusses the research philosophy chosen and the implications that this has on this work.
- Section 3.3 discusses the different methodological tools from the related fields upon which this work is based.
- Section 3.4 discusses the methodological inspiration for this work, Participatory Action Design Research.
- Section 3.5 discusses the modifications to and implications of the Participatory Action Design Research approach that this work is taking.

3.2 Research Philosophy

Any research being presented needs to discuss and then declare, either by implicitly or explicitly stating, the philosophical underpinnings of the work. There are a myriad of different approaches to understanding and viewing the world, each with their own advantages and disadvantages, and each approach has implications toward the research and how it will be undertaken (Burrell and Morgan 1979). As such, a body of work that has not provided this information is open to other researchers misunderstanding and misinterpreting the work when they view it through their own lens of the world as opposed to the lens used by the original researchers. This section will discuss and provide the lenses used during this work.

Guba and Lincoln (1994) state that when trying to decide upon a research philosophy and methodological approach that there are three main questions to consider:

- *Ontology*: what is the nature of existence?
- *Epistomology*: what relationship exists between the inquirer and the knowledge they seek?
- *Methodology*: how can the inquirer discover the knowledge?

These three topics heavily affect one other. A decision made at any point will influence the available options at the other stages.

3.2.1 Ontology

There are two main ways of consider the nature of the empirical world: objectively and subjectively (Orlikowski and Baroudi 1991). The objectivist sees the empirical world as independent of humans, existing without our interference or biases. The subjectivist, however, sees the world as coming about through the actions and inputs of the people who are a part of it.

This research is an attempt to understand how mobile technology is being used in communal public space, and then to use this understanding to improve the experience of participating in such a space. These research goals must both be considered from a subjective view, each person in communal public space is interpreting the experience in their own ways. These goals cannot easily be understood in an objective fashion.

3.2.2 Epistemology

There are different ways a researcher can approach the interaction they will have between themselves and the knowledge they seek. Two of the more common approaches are positivism and interpretivism. Positivism takes the approach that all knowledge is only valid when it is derived from the observational data. People's opinions and the beliefs that interact with

them take no part in knowledge. Interpretivism takes the almost opposite view, all knowledge is tied up in the social fabric that helped to create it and any information gathered cannot be understood without being impacted by the people who were involved in the work.

The ways in which people interact with technology in communal spaces are going to be impacted by the social interactions that drive people to interact with the technology in the first place. As such, the reason *why* people interact with technology will be paramount to this research creating a coherent picture and this understanding will be heavily impacted with the internal biases of the people involved. For this reason this work has to take an interpretivistic view.

3.2.3 Methodology

The final question to be answered: is what tools and techniques will be used during the research? This research takes a subjective and interpretivistic view towards the research, and the methods used need to reflect this. This work is taking inspiration from a methodological approach from urban informatics called Participatory-Action-Design-Research, discussed further in Section 3.4.

3.3 Tools for Research

Communal public spaces research comes from a variety of different fields, each with their own approaches toward research and methods to undertake. This section will discuss some of the previous methodological approaches used in the different fields. The remainder of this section is as follows:

- Section 3.3.1 summarises the methodological approaches undertaken

in the informatics and social sciences fields.

- Section 3.3.2 discusses the various research methods used in urban planning and architecture studies.
- Section 3.3.3 analyses the variety of methodologies used in the computing fields: Human-Computer-Interaction, Ubiquitous Computing, and Urban Informatics.
- Section 3.3.4 discusses which methodological approach this work is going to use, based upon the different approaches previously mentioned.

3.3.1 Information Seeking and Library Informatics

Information seeking including library informatics, and a variety of its cognate fields' studies, form a large part of the underpinning that makes up communal public spaces. They contribute greatly to understanding how people and information exist together in such spaces. As such, their methodological approaches are worth considering to form the basis of this research. One of the initial impetuses for this work was the field of information grounds (Section 2.4) which have been involved in the research of a variety of different communal public spaces. Information grounds research derives itself from Pettigrew's (1999) social constructionist approach (Tuominen and Savolainen 1997) into a study of a foot clinic. From this point a variety of different research projects have been using information grounds for a their various goals. The approach they take depends on the precise goals of the study, however, there are some commonalities. Since the 1980s, research in information seeking has taken a much more qualitative and open approach as opposed to the previously exclu-

sionary and quantitative approaches of the early work in the field (Fisher and Naumer 2006).

The general approach taken by information grounds research and similar fields focussing on information and place, such as The Third Place and communities of practice (Oldenburg and Brissett 1982, Lave and Wenger 1991), is heavily ethnographic. Very often observation is a core component of the research and will generally be used in conjunction with interviews and conversations with the people (Pettigrew 1999, Fisher et al. 2004). Other approaches taken include very broad (but still open) surveys, including large phone surveys and university student surveys (Fisher et al. 2005, 2006). As discussed further in Section 2.4, despite a few exceptions (Counts and Fisher 2008) the role technology plays in information research is poorly studied, and as such methods for understanding this role are also poor.

3.3.2 Urban Design Approaches

The urban design and architecture fields are another large part of communal public spaces, providing insight into how public spaces are created and used by people. The field, however, is comprised of a mishmash of different ideas and principles from architecture, zoning and building rules, sociology, art, and engineering. As such there are a variety of different methodologies being used in the field as a whole, each depending upon the goals of their particular project. Compared to the other disciplines in communal public spaces research, urban design is a very old field and as such moves at a slower pace. Like all research domains it has its own internal biases which build up over time and affect the way research is done.

Groat and Wang (2002) described three main approaches to research theories in the field: normative, polemical, and explanatory. Normative

theories are those which present policies or procedure, cultural practices to be considered, and are generally derived over many years. An example of one such practice is the spacing of floor joints in the US, which should be spaced at 16 inches; any less is wasteful and any greater is too bouncy (Groat and Wang 2002). Polemical theories, on the other hand, are similar to normative theories but are speculative, personal recommendations (Groat and Wang 2002). Explanatory theories are attempting to create generalised, or a collection of, principles to explain phenomena (Groat and Wang 2002). These vary on what exactly the goal of the work will be. As such, this encompasses research from discovering what effect street layout has on walking (Spielberg 1989, Saelens, Sallis and Frank 2003); to attempting to understand social practices through a longitudinal observation of a post World War II US town (Gans 1967). This research is most interested in the work using explanatory theories, but as stated earlier urban design is a very old field and changes very slowly in comparison to the other research domains. Therefore there are many research methods that are of little use to this work. Until the 1960s, research in urban design had very little desire to understand how the human experience was impacted by, and itself impacted, the urban space (Bentley 1985, Taylor 1998); the very aspect this work is attempting to better understand.

The research from urban design that this work uses places more importance on the person in the space, using ethnographic-heavy techniques, in particular observation. The use of technology, and the impact of technology, is however poorly represented in urban design research.

3.3.3 Technocentric Approaches

The final collection of fields are those that take a technocentric approach, these research domains are those that place an emphasis on the impact

that technology has on a place, especially when compared to the above domains. The technocentric fields grew out of HCI and it's desire to create more useable technological artefacts. With such a beginning it is natural that the research performed has a focus on the technological, however research in HCI and related fields are in a period of flux.

This flux is to be expected in what are relatively recent research disciplines. The field is transitioning from applied science evaluations and usability experiments to ethnographic and in-the-wild understandings of place. In 2003 Kjeldskov and Graham performed a survey of the variety of different research methods and approaches being used in mobile HCI by investigating 102 papers from the top conferences in HCI and related fields, such as CSCW and Ubiquitous Computing. These papers were categorised and grouped, after which research methodology trends could be examined. The work showed a very heavy bias in mobile HCI research towards applied science approaches to engineering a technological artefact (45 of 102 papers), or for lab experiments to evaluate a technological artefact (30 of 102) (Kjeldskov and Graham 2003). This led the authors to declare that *"the view that building and evaluating systems by trial and error is better than grounding engineering, evaluation and theory in user-based studies weakens research in mobile HCI"* (Kjeldskov and Graham 2003, p.326). The conclusion of the article called for researchers to ground their evaluations more heavily in the spaces before beginning any work. A related article published only a year later investigated whether or not field experiments–as opposed to lab experiments–were worth the extra time and cost they require (Kjeldskov, Skov, Als and Høegh 2004). The authors compared two usability evaluations, one in the field, the other in a lab, and discovered that the differences between the two experiments were very minor, leading them to ask the question *"Is it worth the hassle?"* (Kjeldskov et al.

2004).

Advance to 2012 and the research world of mobile HCI and related fields has changed a great deal. Kjeldskov and Paay (2012) performed an analysis of research methods as a follow up article to the original 2003 article and it showed how in less than decade the field had undergone quite a change. There was still a bias towards engineering a solution and evaluating the solution in a laboratory setting, but the review showed that there is an increase in the number of field experiments and studies whose purpose was not to engineer a solution but simply to understand a place or problem better. This change led the authors to see mobile HCI as following two main approaches, *people* and *systems*, depending on whether the focus was on understanding or evaluating, and to express a desire to see these two approaches merge together over time (Kjeldskov and Paay 2012). This trend toward a greater understanding and grounding in a space was also echoed by another follow-up article to the 2004 article on lab versus field evaluations (Kjeldskov and Skov 2014). This article looked at the responses to, and uses of, the article asking the question whether field studies are worth the additional cost and time. The responses and uses of the paper help to indicate three things: that there is a change in the research toward a more holistic approach, that more *"in the wild"* (Crabtree, Chamberlain, Grinter, Jones, Rodden and Rogers 2013) evaluation and understanding are important to *"seek to understand and shape new technology interventions within everyday living"* (Crabtree et al. 2013, p.1), and that the desire for generalisability is perhaps less useful to the field than a proper understanding of a space and how the people in it exist (Kjeldskov and Skov 2014). The paper concludes that the field has a good understanding on how to build systems, and in general needs to move away from simply creating and performing usability evaluations on artefacts. Kjeldskov and Paay's (2012)

paper into research trends shows that this movement is already happening. The future should be using approaches and methods that encourage in-the-wild understanding of a space and any artefacts introduced into it. It is no longer a question of whether these approaches should be taken, but when they should be taken (Kjeldskov and Skov 2014).

Urban informatics on the other hand has both a similar, and a different approach to research. Urban informatics could be considered part of the HCI fields, but can also be seen as separate, sitting on top of HCI and including a variety of other fields. The different number of fields that comprise urban informatics gave it a unique start to begin research from HCI, effectively skipping the decade or so of HCI where the research was heavily biased towards only engineering and applied science. Despite this, urban informatics is still heavily technocentric (Tacchi, Slater and Hearn 2003, Hearn and Foth 2005), making it *"interested in how ubicomp artefacts can enhance the communicative ecologies"* (Bilandzic and Venable 2011, p.2).

Based on the desire to better understand and to handle the *"messy"* (Baskerville, Pries-Heje and Venable 2007, p.17) interactions that such a grounded approach to a communicative ecology entails, a study into urban informatics methodology stated that urban informatics research has mostly settled on variants of either action research (an approach Kjeldskov and Paay (2012) desired to see more of) or design science research (Bilandzic and Venable 2011). When Bilandzic and Venable (2011) wrote about the methodological challenges facing urban informatics, one of the sections discussed the adaptation of action research for more technocentric research fields, resulting in a slew of action research inspired methodologies being created and used. These include canonical action research (Davison, Martinsons and Kock 2004) as a general purpose information systems research methodology, ethnographic action research (Tacchi et al.

2003, Tacchi, Foth, Hearn et al. 2009) for understanding and developing community ICT solutions, or network action research (Foth and Adkins 2006) seeking to increase the amount of participation amongst the researchers and urban community members. In the end, the primary differences between these approaches is the degree in which they encourage participation amongst the community and the researchers.

Design science research, on the other hand, came about due to a desire to formalise the part of technocentric research responsible for the building and evaluation of relevant artefacts. This was in response to the heavy focus that action research and its related methodologies took on primarily understanding the behaviour (Hevner, March, Park and Ram 2004). Similarly to action research, the design research methodology has been adapted and modified as needed. Some examples of these modifications are soft design science methodology created by combining soft systems methodology (Checkland 1981) with design science research (Baskerville et al. 2007) to better associate a solution to its problem, and action design research (Sein, Henfridsson, Purao, Rossi and Lindgren 2011) arguing that any solution must emerge from the interaction and evaluation of the design and the people using it, which Venable (2006, p.185) called *"naturalistic evaluation"*. There have also been attempts to understand better how action research and design research are similar and dissimilar to each other (Iivari and Venable 2009), which ultimately lead up to the modification and adaption of both methodologies to be merged together into new methodological approaches incorporating the best of both (Bilandzic and Venable 2011).

In summary, with the technocentric research fields there is a push for research to be more heavily grounded in a space or problem, to perform more in-the-wild research approaches, and to get a better understanding before introducing an artefact (should it be warranted).

3.3.4 Choose Wisely

These myriad approaches to researching and understanding communal public spaces show a bias towards subjective and interpretivistic techniques. There have been heavy focusses on ethnographic techniques in most of the supporting research and as such this work must also follow this model. In many ways the different fields which make up communal public spaces are slowly trending towards each other in approach. The more technocentric fields are starting to take larger ethnographic and holistic views of the spaces they are investigating while at the same time urban planning and informatics research are starting to appreciate the impact technology has on the research. In time the differences between the fields from a research perspective may merely be the goals and focus of the work.

Until the fields do merge (if ever), the precise approach to take needs to complement the many worlds into which communal public spaces research falls while at the same time not ignoring any of the goals of this work. Because of this, this research is embracing an approach from the urban informatics field: Participatory-Action-Design-Research. The reason for this is due to urban informatics view towards technology needing to be a part of a place to be useful and to be appropriated by the participants. Additionally, urban informatics' approach towards exploring a place is ethnographic allowing for rich pictures to be created but still encourages action in the form of technological interventions. These are all important components of the myriad fields that make up communal public spaces, as such choosing urban informatics methodologies allows for the greatest intersection amongst the disparate fields to occur.

3.4 Participatory Action Design Research

Participatory-Action-Design-Research (PADR) was created as an attempt to unify the variety of different methods and approaches used to undertake research in the urban informatics field and to answer the question *"What would be the characteristics and structure of a good method for conducting Urban Informatics research?"* (Bilandzic and Venable 2011, p.4). As discussed in Sections 2.7.3 and 3.3, this work does not consider itself part of the urban informatics field but does borrow very heavily from, and agrees with the core goal of, technology enhancing the urban landscape. As such the methodologies which apply to urban informatics are a good choice for this work. The structure of PADR gives it the appearance of a rigorous set of steps to be followed exactly but this is not the case. It is more akin to a guide offering structure to create a methodological approach.

The PADR approach was born out of an attempt to merge the more traditional ethnographic-heavy approaches to understanding place with the more technocentric approaches to building and evaluating artefacts. The original work that created the PADR approach was part of a PhD into Hybrid-Placemaking: tying digital spaces to physical ones, with a focus on creating and optimising a hybrid place to encourage social interaction at a co-working space (Bilandzic 2013b). The creators of PADR eventually settled on attempting to combine the best components of action research with those of design research without losing the parts that made either methodology useful in their own ways. The different aspects of the contributing methodologies were combined together into a five phase approach:

1. Diagnosing and Problem Formulation.

2. Action Planning.

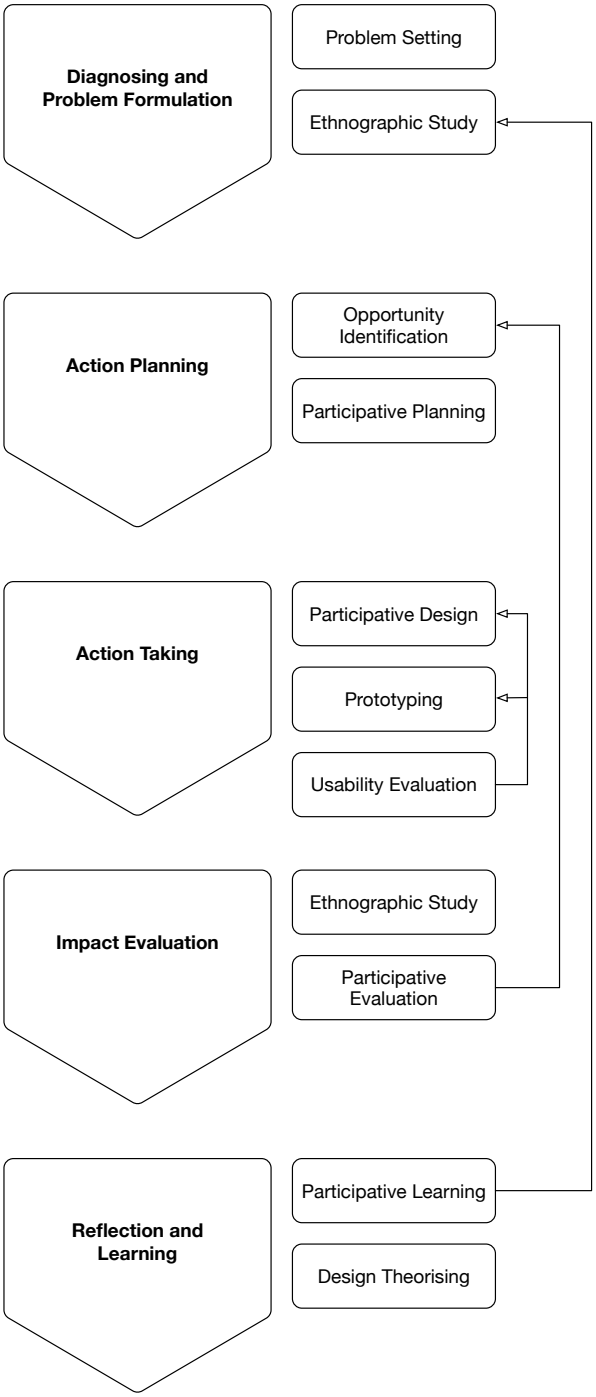


Figure 3.1: Participatory-Action-Design-Research phases. Reproduction from (Bilandzic and Venable 2011)

3. Action Taking.

4. Impact Evaluation.

5. Reflection and Learning.

PADR–much like its inspirations, action research and design research–is an iterative approach; the phases are not intended to be performed in isolation with only the previous phase feeding into the next. After the Impact Evaluation phase the findings should feed back into the Action Planning stage and the Reflection phase is intended to feed back into the Diagnosing phase once more. In addition to this, during the action-taking phases of the methodology it is assumed that the design and implementation of any artefacts will be adapted based on feedback during its design and evaluation. The iterative nature of PADR is shown by the arrows in Figure 3.1.

The remainder of this section will discuss the different components of PADR, and how they interact, and how they have been used to date.

3.4.1 Diagnosing and Problem Formulation

The first stage in PADR is to diagnose and understand the space and to identify the problem(s) that exist within. As PADR comes from the urban informatics space (itself heavily tied to the ubiquitous computing field), it requires the assumption that a space will have a problem, or problems, to be solved. This also goes hand-in-hand with the assumption that a technological artefact of some sort will resolve the issue. The original article that created the PADR framework took the approach that ethnographic methods and approaches are the ideal way to understand a place and to provide a basis for the next phases of the PADR approach (Bilandzic and Venable 2011). There are some issues with using ethnography in this manner, however. Ethnography is not designed for the purpose of extracting and iden-

tifying issues that technological artefacts can solve (Hughes, King, Rodden and Andersen 1995). Ethnography also is a long and slow process (Millen 2000)–traditionally taking months to complete–and the use of technology is changing at such a rapid pace that any insight gained might well be for a different world than one into which any change is introduced (Gordon and e Silva 2011). Finally, the idea of repurposing ethnography for requirements elicitation alone has been criticised (Dourish 2006a). Ethnography gives an insight into how a space and the people within it interact and exist; using it solely to elicit design implications misses the purpose and value ethnography brings to a research space (Dourish 2006a).

Because of these issues, a variety of different approaches were developed to applying ethnography to computing research (Millen 2000, Tacchi et al. 2003, 2009). These quick and dirty (or rapid ethnographic techniques) provide an ethnographic approach with shorter and less researcher-intensive methods for gaining insight into a space.

The work which created the PADR framework also took these previous concerns and improvements to using ethnography in computing research to heart when recommending which techniques and methods to use. The original suggestion was to use cognitive maps, rich pictures, or coloured cognitive maps to elicit and understand a space (Venable 2005, Bilandzic and Venable 2011). The original work to use the PADR framework used a variety of methods from the supporting work: observations of the space, targeted stakeholder interviews, and general space participant conversations (Bilandzic and Foth 2013).

3.4.2 Action Planning

The second stage of PADR is where the researcher begins to look at the issues identified and attempts to create a solution to resolve or ease these

issues. This stage has two main components: opportunity identification and planning. The opportunity identification step is where any problems uncovered in the diagnosing stage can be inspected from the perspective of how to solve the problem. Such a solution does not *have* to be a technological artefact but in computing research fields it often will be. The second component is the planning stage, where the design of the solution and how it would be used and evaluated begins.

The authors of the PADR discovered *how* can the findings be understood and presented was an issue (Bilandzic and Venable 2011). The creators suggested the use of design personas, *"composite user archetypes"* (Cooper, Reimann and Cronin 2007, p.82), allowing the problems and design basis to be easily elucidated. The first work to use to the PADR approach also followed this suggestion and created five personas to represent the people and their issues identified at a co-working space (Bilandzic and Foth 2013).

3.4.3 Action Taking

This third stage is where a researcher can begin to take action by creating a solution to the problem (often a technological artefact) and evaluating it in the space. This stage of the framework is heavily iterative. Any solution is expected to be evaluated in the space with the people who are members of the space, and any insights gained during this evaluation should be fed back into the next iteration of the artefact to be evaluated. The design and implementation should be participatory with the researcher and the people who use the artefact being those who give input into the design, changes, and additions. This stage of the framework should use a combination of methods to feed back into the iteration of the artefact. The formative article of PADR recommended usability evaluations to improve the design as well as more in-the-wild evaluations (Bilandzic and Venable 2011).

The original work using PADR introduced two different interventions: one was the beginning of a regular meet-up for *hacking* described as a social intervention (Bilandzic 2013a), the second was a technological artefact to encourage ad-hoc meetings in a library co-working space (Bilandzic et al. 2013). Both of these were designed in relation to the previously identified personas and observations and were heavily iterative in their attempts to encourage place-making.

3.4.4 Impact Evaluation

The point of this phase is to see what impact, if any, the artefact has had on the space and the people in it. This stage is open to interpretation as to required actions, and will change depending on the goals of the research. If, however, the impact of the artefact is non-existent, negative, or not what is intended, this phase of the research is a good point to iterate back to the action planning stage and start once more. The results of this stage, and all other previous iterations, will then be used to feed into the final phase of PADR. The original research which created the PADR framework suggested that ethnographic methods, and in particular a long-term ethnographic approach, would be the best to properly understand the impact of the artefact, especially if used in combination with immediate in-the-wild usability evaluations (Bilandzic and Venable 2011). Much as with the earlier phases of PADR, the original authors also realised that in many cases a 'proper' ethnographic study might not be possible because of the constraints of the research and that shorter ethnographic approaches might be better suited (Tacchi et al. 2009, Bilandzic and Venable 2011). The original research to use PADR used a combination of ethnographic techniques, mostly focussing on conversations, both individual and group, and observations both of the space and how people interacted with the intervention

introduced (Bilandzic 2013a, Bilandzic et al. 2013).

3.4.5 Reflection and Learning

The final stage in the PADR framework, Reflection and Learning occurs when the iteration of the artefact has ended and the research has met goals which make it a worthwhile point at which to stop. As the name of the phase implies, this is a reflective phase; all the information from the earlier phases are used in understanding the outcomes from the research. The reflection should ideally be participatory, and the key stakeholders in the space and those involved in the earlier phases should be involved in reflection where possible (Bilandzic and Venable 2011). Much like in earlier stages, this is another iterative point in the framework. The reflection stage is a good point in time to loop back to the very first phase and begin the process again; this may or may not be possible or worthwhile depending on the goals of the research.

The outcomes from this phase are dependent upon the specific space being investigated, the people involved in the research, and the original goals for the research. The PADR framework suggests creating a design theory to communicate the results of the research. The first work to use the PADR approach created a series of guidelines to consider when engaging in hybrid-place making and when facilitating collaborative learning (Bilandzic 2013b).

3.4.6 Data Analysis

Raw data itself is not of great use to a researcher. It needs to be analysed before any meaningful results can be extracted from within its morass. Curiously enough, the approach for analysing collected data was not explained

by the creators of PADR. It can, however, be extrapolated based upon the work which was used to create PADR in the first place and upon related research approaches used by similar research projects under the HCI banner.

The possible ways to analyse data are many and each has its own strengths and weaknesses as well as a multitude of variants and sub-variants upon the same base idea. One of the more common is a collection of techniques grouped together under the banner of Grounded Theory (Strauss and Corbin 1990). Grounded theory allows a researcher both to pare the raw data into amounts that can be more easily understood and to provide ways to derive useful insights from the newly summarised data. This approach has been seen as unnecessarily complex for HCI research (Paay et al. 2009). In this work however, the extra complication is considered to be worth the time.

The myriad methods encapsulated within grounded theory and its many variants (collectively called Grounded theory Methods or GTM) provides a strong explanatory narrative from the data, enables the researcher to see how the different components relate (or not relate, as the case may be), and also allows the researcher to extract multiple perspectives from the data (Braun and Clarke 2006, Boyatzis 1998). GTM usage in computing research, such as this work, will generally follow a standard approach. First, the domain and data types are identified and the relevant data is collected (Muller and Kogan 2010). The data will then be transcribed and the researchers will spend a significant amount of time reviewing the data, in order to become familiar with it. Themes, codes, and categories from the data are then iteratively analysed and identified. The different categories are then related to one another. From this the structure of the data can be found.

A major component of the GTM approaches is the coding of the data.

Coding is the identification and extraction of key pieces of information from the data, and there are many different ways of coding data and each has its own strengths and weaknesses.

One of the more common, and often the first analytical step in many GTM, is open coding. Open coding allows the researcher to begin forming concepts within, and to grasp the different aspects of, the data (Strauss and Corbin 1990). The codes are developed and identified based upon their properties and then iterated upon; collections of codes are found and merged together based on their similar thematic elements. This process is repeated numerous times until the researcher has reduced the initial data to a level from which they are capable of deriving a structure.

It is worth stating that GTM is not an off-the-shelf methodology and that the individual tools and methods encapsulated within GTM each have their own effective uses outside of the banner of grounded theory. As said by Strauss and Corbin (1990, p.306), when discussing open coding within grounded theory: *"Although if your purpose is just to pull out themes, then you could pretty much stop here."*

Due to the open nature of using GTM, it makes them ill-suited for exploring hypotheses. Rather, they are by design intended to allow researchers to create hypotheses from data (Suddaby 2006). GTM gives researchers a means to approach data and understand their data; they do not tell researchers how that data can or cannot fit into an existing concept. This makes GTM inductive methods, and any research using them must therefore also be inductive (Suddaby 2006)

The approach that this work takes follows a fairly common approach often used in HCI research fields. The data types and domain were known in advance, then data was collected and codes and themes were identified through an iterative approach. This does not align perfectly with the tradi-

tional grounded theory approach described by Glaser and Strauss (1967), but is still a good match for the goals of the research and allows for an in-depth exploration of the data. The remainder of this section will discuss how the data collected during the research was analysed using a GTM approach, covering the three steps to be used in all phases of this research: data familiarisation, data coding, and finally grouping of the codes into themes. These three steps are based on the work of Strauss and Corbin (1990).

Data familiarisation

For a researcher to be able to extract any useful theories and information from raw data, they are required to be familiar with that data. To further that goal, researchers should spend a significant amount of time reading and then re-reading the data. This should continue until the researchers feel they are comfortable with, and have a proper understanding of, the data at hand.

The purpose of this familiarisation is not as an aid to memory; it is to give the researchers grounding which they can then use to begin coding the data. Without this grounding, coding the data would very likely be a much slower process as the intricacies of the data itself would not be as well understood. Additionally, without the grounding the coding would also likely result in different codes being identified, as without a solid understanding of the data, reading the data whilst trying to code it would result in frequent back and forth shuffling in an attempt to comprehend how one word or phrase can be seen in the context of the others.

In the case of this work, the author extensively read and then re-read the results of the survey and the transcripts of the interviews multiple times over a period of a week following the conclusion of the data collection.

During this process some simple notes were taken based on the author's thoughts on the interview and survey data, however, no coding took place during this period. Once the author felt that the data was sufficiently familiar, the next phase, coding, was undertaken.

Data coding

The many different approaches to grounded theory make use of many phases of abstraction from the data. As stated by (Strauss and Corbin 1990), open codes by themselves are useful in the early stages of exploring a subject. For this reason, open coding was used in this work and were then refined into the themes discussed later in Section 4.3. The *open* part of open coding refers to the codes being identified during the many passes through the data; there were no codes for the data in existence before the coding began. The process of creating the codes was iterative, where the data from both the survey and the interview were reviewed, with repeated and important terms being identified and marked up as a code. Figure 3.2

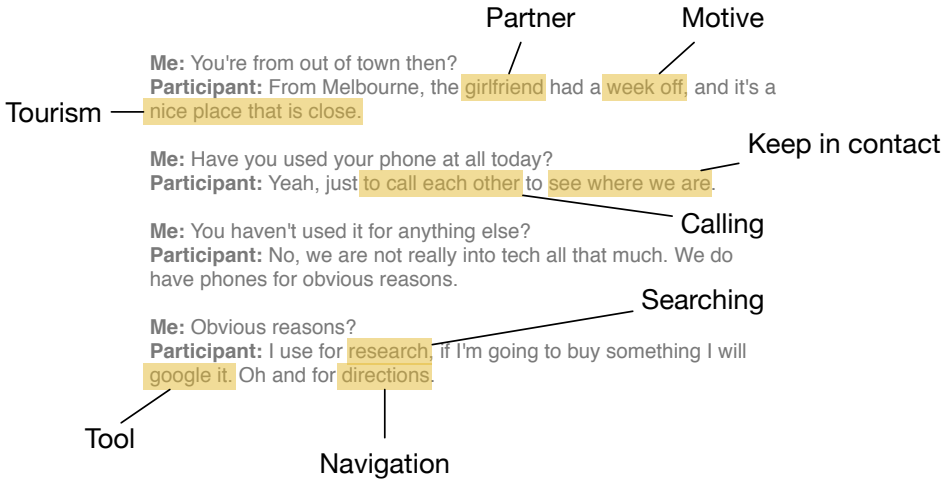


Figure 3.2: An example of the coding process

shows an example of how the codes were created from the raw data.

Data themes

After the initial set of codes were identified, the individual codes are grouped together by their similarity with each other. These groups of codes became the themes (those created in this work are discussed in Sections 4.3.1, 4.3.2 and 5.7).

3.5 PADR and this work

At its core, urban informatics is a field still heavily tied to the computing discipline and as such it has the more traditional desire to use technological artefact to *fix* a problem. This of course assumes that there is a problem needing to be fixed. This research does not subscribe to this belief; it takes the approach that a place can exist without a problem. This work does, however, take the view that a space can still be positively enhanced through the addition of technological artefact(s) and because of this a methodological approach attempting to understand a space and then fix the problems within it has still has validity for this research. PADR is also quite well suited to support the impact of technological artefacts in that it covers the gamut of insider and outsider views as means of inquiry (Evered and Louis 1981, Brooks and Alam 2013), allowing support for both controlled experiments as well as deep ethnography in the one research project.

3.5.1 Diagnosing and Problem Formulation

As stated earlier, the first phase of the PADR approach is to try to both diagnose and understand the space and any issues that might exist within

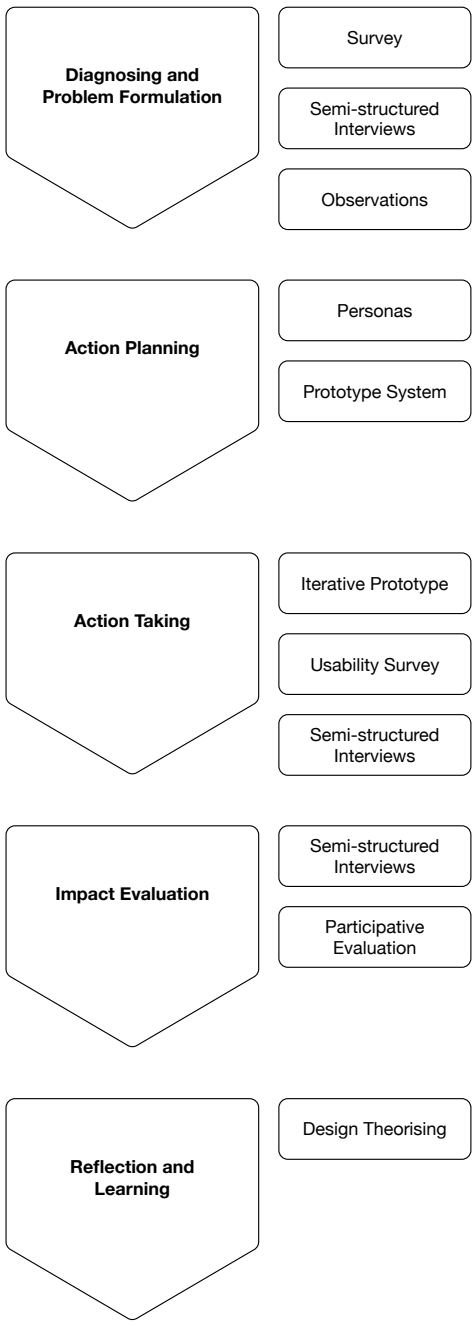


Figure 3.3: The tools this work will be using.

it. The suggested approach was through ethnographic and rapid ethnographic means. Like the original work to use the PADR framework, this work uses observation, surveys, and semi-structured interviews, all discussed in further detail in Chapter 4.

These three methods, with the exception of observation, were not described in the original PADR framework, nor were they used by the study which used PADR, although they are mentioned in the supporting papers that lead to the creation of PADR (Tacchi et al. 2009). These methods, however, are still valid for use in this work. Surveys are a common technique in mobile human-computer interaction fields (Kjeldskov and Paay 2012), and between an initial survey in 2003 and the follow up survey in 2012, the use of survey research has almost tripled (Kjeldskov and Graham 2003, Kjeldskov and Paay 2012). Despite surveys having weaknesses in providing in-depth information they do provide a very rapid means of gaining initial insight into a space (which is precisely why this work uses them). Semi-structured interviews, on the other hand, offer a greater deal more insight than the surveys but also take more time. The interviews in this work follow the approach taken by Tacchi et al. (2009), providing a list of major topics to be focussed upon while still leaving the researcher and the participants room to expand into new areas of discussion.

3.5.2 Action Planning

This phase of this work matches very closely to both the formative PADR article and the first research to make use of it. Just like the aforementioned works, this research uses design personas to help elucidate the goals and technology use of people in outdoor marketplaces.

Concerns in the literature have been raised about the applicability of personas to the real world, in that is difficult to verify if the persona matches

correctly with the collected data (Chapman and Milham 2006). While this risk does exist, this work takes the approach that a persona approach is still worthwhile. Personas are a popular tool (Chapman and Milham 2006, Pruitt and Adlin 2010) as well as being a recommendation of the original work to create the PADR approach (Bilandzic and Venable 2011), as such this work considers it reasonable to continue to use personas. The risk that the personas may not directly tie back to the participants does still exist, to help mitigate this risk the personas alone will not be the basis of a decision and direct feedback and the analysis of the aforementioned will also be used. See Section 4.4 for full details of the personas used in this work.

Also, just like the earlier work, this research is also using a technological artefact, in this case a mobile application (Chapter 5) as opposed to an interactive display. The greatest difference between this work and the original study using PADR is that the original work also had a non-technological, social event as another means of encouraging change in the space.

3.5.3 Action Taking

Much like the above phase, this phase of the work again follows very closely the recommendations and previous practices of PADR. As mentioned earlier, this research involves a technological artefact. The artefact, a mobile application, is also heavily iterative (see Chapter 5 for details), with each evaluation of the prototype system being used to feed into the next. This work also uses semi-structured interviews, for the same reasons discussed in Section 3.5.1. It uses a standardised usability survey to help gain a quick understanding into the efficacy of the prototype and to help iterate the system. This use of multiple data types is not only recommended by the PADR framework, but both of the methods used are very common to the mobile HCI field (Kjeldskov and Graham 2003, Bilandzic and Venable 2011).

3.5.4 Impact Evaluation

The penultimate stage of PADR is to see what impact the artefact is having. The original work into PADR suggested ethnographic methods, with a preference towards a long term study but also accepting that few research projects would be able to do so (Bilandzic and Venable 2011). In that case, the original work suggested that time shortened ethnographic methods would also be acceptable. The original research used conversations and interviews. This work uses interviews, for the same reasons already provided in this chapter.

3.5.5 Reflection and Learning

The final stage of the PADR approach is to present the findings and share these results back to the world. In the original work that created the PADR framework the recommendation was to create a design theory (Bilandzic and Venable 2011) and the original work using PADR created a series of design guidelines for future developers and researchers when exploring hybrid-place making (Bilandzic 2013b). For this stage of the PADR in this work, the findings will be distilled into a design framework to help guide future work in communal public spaces. This framework is discussed in detail in Chapter 6.

3.5.6 Data Analysis

This work embraces a standard approach to the analysis and understanding of the collected data, using an approach inspired by grounded theory. For more details on the different stages involved in the analysis performed in this work, see Section 4.2.5 and Section 5.5.5. As described in Section 3.4.6, the three main components of the grounded approach in this

work are the data familiarisation, the data coding, and theming.

Familiarisation

In this work the data familiarisation was done in two different ways: one for the paper survey and interview data, and one for the audio recorded interview data. The data familiarisation for the survey and initial interviews was performed by the researcher reading the information collected until they felt confident that they had a firm understanding of the data. The audio interviews, however, were coded directly from the audio, and as such familiarisation was slightly trickier. In this case, the researcher listened to interviews until they felt they had an understanding of the data, which took longer than for the written interviews.

Coding

For this work, coding was performed by the researcher in two different ways. The first way was directly from the surveys and initial interviews, where the researcher read through the data and wrote down relevant codes as they were discovered and interpreted by the researcher. Secondly, the audio interviews were coded live from the audio itself without any transcription. Coding however was remarkably similar to the transcribed data and was fast enough to negate any need to transcribe the data from the audio. When relevant codes were discovered, the researcher would pause the audio and write down the code as well as an approximate timestamp for when that code was uncovered (for later retrieval if necessary). For a discussion on the implications of the audio coding see Section 5.5.

Themes

The final stage was to combine the different codes together into themes. This was performed identically for all the different data collected. The individual codes were examined and combined together by the researcher from their understanding of the data and the codes. At this stage some codes were broken up into new codes and others were merged together. The themes from the survey were used to create the focal points for the interviews and the themes from the interviews form the basis of the discussion of how technology is being used in marketplaces. The themes from the group interviews in conjunction with the rest of the work formed the basis of the theoretical contribution of the work.

3.6 Summary

This chapter presented the methodological approach that the rest of this work will be using, Participatory-Action-Design-Research (PADR). PADR was chosen as the basis for this due to its use in the related field of urban informatics and for providing an already constructed and proven approach to exploring complicated spaces. A summary of the different stages in PADR was given in Section 3.4 and Section 3.5 provided a description and justification for the approaches and modifications of PADR that this work will be using. A diagram of the approach is shown in Figure 3.4, including a breakdown of how the remaining chapters of this document relate to the methodology.

The next steps for this research is to begin the exploratory and experimental stages of the work by following the approach described in Sections 3.5.1 to 3.5.4 of this chapter.

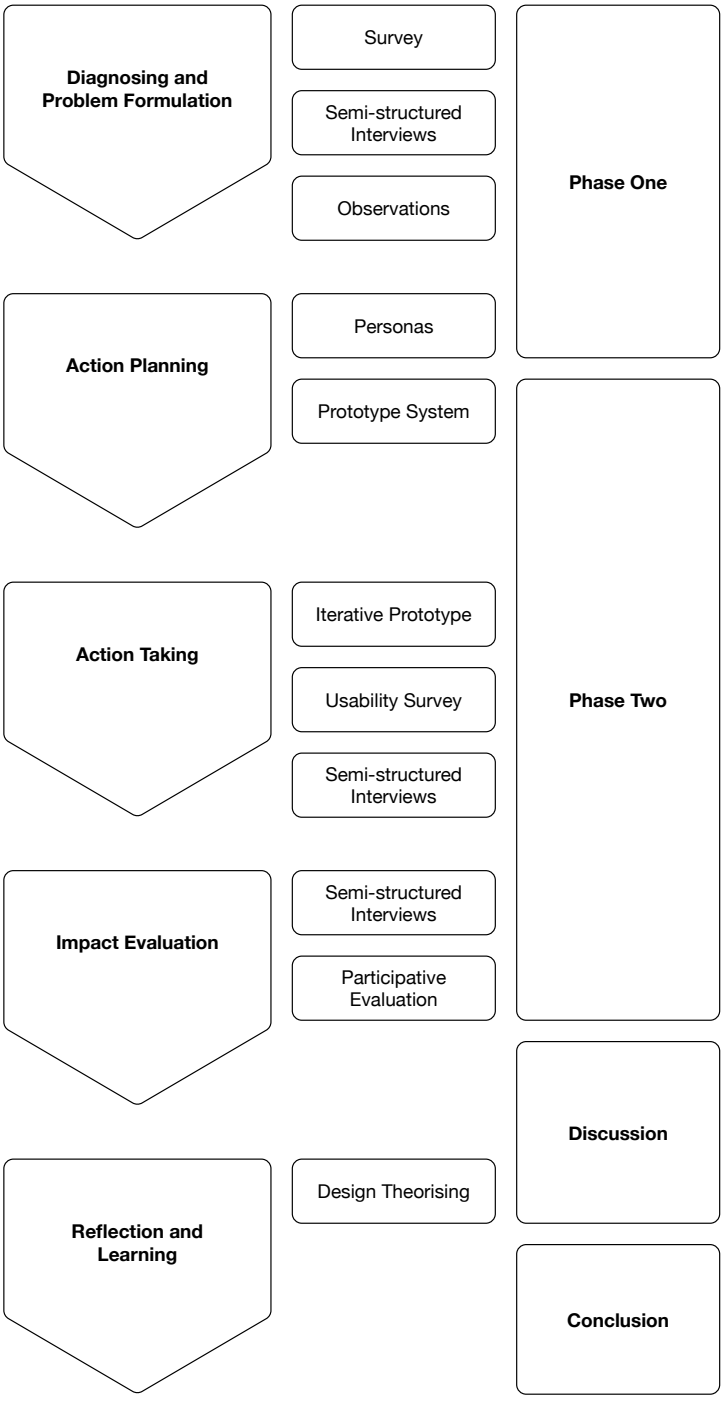


Figure 3.4: The methodological approach for this work.

4

Phase One: Exploring the Space

4.1 Introduction

This chapter presents the first phase of this research: an initial study consisting of a broad survey and a follow-up series of more focussed semi-structured interviews probing the use of mobile technology and awareness systems by participants in communal public spaces. The specific goals of this phase of the research were:

- To validate the research area by exploring:
  - whether mobile technology, such as awareness systems, are in use by the visitors to the marketplaces;
  - what components and features of mobile systems are currently being used by marketplace participants.
- To uncover what areas of mobile awareness functionality (if any) are currently lacking in support, or are currently unsupported, in communal public spaces.

- To gain a better understanding, both specifically related to technology and, in general, of the goals and motives of participants of communal public spaces.

Three data-collection tools were used in this phase of the research:

- *Survey*: a series of related questions in a paper survey format distributed to the attendees of the markets and collected by the researcher.
- *Semi-structured interviews*: interviews using a series of open questions focussing on specific activities at the market with the intent of using the answers as a catalyst for more advanced discussion.
- *Observations*: audio recordings of the market attendees taken by the researcher, describing what was being seen.

A total of 47 participants took part in the study. All participant data was transcribed and coded using an approach based on grounded theory. For full details of the analysis of the data see Section 4.2.

4.1.1 Objectives and motivations

This work began as an exploration of the potential of using information grounds, and specifically the People-Place-Information trichotomy (PPI) from information grounds, as a means of understanding space for future technological intervention. One of the goals of the PPI was to be used as a starting point for technological intervention but to date it had not yet been investigated. The original motivations for this stage of the work was therefore simply to apply the PPI to the marketplaces and see what potential it had to encourage and support technological intervention. This changed as the work evolved. This focus shifted away solely from information grounds and as such so did the objectives of this stage of the work:

from using the PPI to explore the space and thereby justifying the PPI to exploring the space, to better understanding the space as a communal public space. The PPI was still used in this stage of the research as a framework to help explore the markets as the basis for the survey used in this stage of the work.

The work described in this chapter relates to the first two stages of the PADR methodological approach, Diagnosing and Problem Formulation and Action Planning. As such this chapter will be mostly exploratory, attempting to understand the markets and to create a picture of how they operate and what parts of the place interact well with each other, and what parts of the place are currently causing issue for the market place participants. Closer to the end of this chapter the work will begin to take a planning approach, creating personas as a guide for use in future stages of this research. For more details on these stages see Chapter 3.

Ethics

Both the survey and the interviews used in this phase of the research were approved as Minimal Risk Studies by the Tasmanian Research Ethics Committee, **H0013607** and **H0014178** respectively. See Appendix A for the experimental material for this phase. In addition to formal ethics approval, this research undertook a number of additional precautions:

- At no point were participants encouraged to divulge any personal information that they did not wish to share with the researcher.
- Analysis of the data was carried out only after any identifying information was removed.
- Participants were informed they were free to withdraw from the study at any time before their data was anonymised.

- Participants were informed that no judgements were being made towards their activities at the market, their usage and understanding of technology, or general activities by the researchers.

4.1.2 Markets

Three different markets were used in this phase of the research, two in Australia and one in the United States:

- The Salamanca Markets, Hobart, Tasmania, Australia,
- The Queen Victoria Markets, Melbourne, Victoria, Australia,
- The Portland Saturday Markets, Portland, Oregon, USA.

The majority of the participants, however, come from the Salamanca Markets due to the markets' proximity to the researcher's home location.

Salamanca Markets

Figure 4.1: The Salamanca Markets
(image by Harrison 2010)

The Salamanca Markets is an outdoor street market that runs each Saturday with stalls following and covering the path of the road in the Salamanca region of Hobart. Each weekend the market is created in place with stallholders setting up their stalls before the market opens and packing them up after it ends. Salamanca Markets has over 300 stalls that primarily aim to promote the Tasmania brand, selling local goods and products. Each weekend the same stall will be in the same position as it was the week before. The Salamanca Markets have been running for 40 years with the number of visitors each Saturday ranging between 25,000 and 40,000. The Salamanca Market was used in both the survey and the interviews.

Queen Victoria Markets

Figure 4.2: The Queen Victoria Markets
(image by Alpha 2008)

The Queen Victoria Markets (QVM), located in inner Melbourne, is the largest outdoor market in the southern hemisphere. The QVM covers two city blocks and has a wider variety of goods than either of the other two markets in this phase, with the majority of the space devoted to fresh produce. The yearly attendance of the QVM is approximately 17 million people (Cook 2013). The QVM differs again from the other spaces in that unlike the Salamanca Markets or the Portland Markets, which are set up and taken down each weekend, the QVM runs every day of the week except Monday and Thursday. Finally, many of the stalls in the QVM move on a day-to-day basis. The movement is known in advance, so on a Saturday a

stall might not be in the same location as where it was on a Tuesday, but each Saturday it will be in the same location as it was the previous Saturday. Some of the larger stalls are fixed in their position regardless of the day.

Portland Saturday Markets

Figure 4.3: The Portland Saturday Markets
(image by Morgan 2012)

The Portland Saturday Markets, described as *Sundays too*, is primarily an arts and crafts outdoor market in the Old Town region of Portland, Oregon. The market runs every weekend from March to Christmas Eve and has over 250 stalls, attracting an estimated one million visitors over the course of a year. Much like the Salamanca Markets, the position of each vendor's stall is fixed from one week to the next and again, much like the Salamanca Market, the market place is set up and torn down each weekend.

4.1.3 Contributions

The primary goal of this chapter is to uncover how or whether technology–specifically mobile technology–is being used in communal public spaces using marketplaces as an example.

This chapter contributes an understanding of market places as information grounds through the application of the People-Place-Information trichotomy as well as providing an insight into the general motives and goals of people at the marketplaces. This chapter also offers insight into what technology is being used, and for what purpose. This is then further refined into additionally uncovering where technology is working in market places and where technology is failing to meet expectations. Finally this chapter presents a series of personas as scaffolding for the next stages of this work, and for future work beyond this research.

4.1.4 Chapter Structure

The remainder of this chapter is as follows:

- Section 4.2 reports on the study as it was designed and conducted, the discussion of the participants, the data collection tools, the data analysis, and any challenges encountered.
- Section 4.3 presents the findings of the study.
- Section 4.4 introduces personas intended for future research phases, derived from the findings of the study.
- Section 4.5 concludes the chapter and introduces the next steps of the research in light of the work presented.

4.2 Design

This phase of the research was broken up into two stages: the first used a broad survey, the second used semi-structured interviews. For a full list of experimental materials, see Appendix A.

4.2.1 Participants

The first stage had 30 participants, all from the Salamanca Markets. The second stage had 17 participants from all three markets. Of the 17 participants in the second stage, four were from the Portland Saturday Markets, four were from the QVM and the remaining nine were from the Salamanca Markets. Of the nine participants from the Salamanca Markets, three were stallholders and six were market attendees. Of the 14 non-stallholder participants, nine identified themselves as local and the other five as visitors. A definition of what makes a person local opposed to a visitor was not supplied by the researcher and all participants self-identified based upon their own understanding of the terms. All three stallholders identified themselves as locals.

In both stages of the phase where participants were recruited at the marketplaces, there were no particular demographics being targeted and people were recruited to join simply by the researchers asking people at the market if they wished to take part in the research. There was no incentive, financial or otherwise, offered or given to participate in the study and all participation was wholly voluntary.

4.2.2 Survey

The survey was comprised of two main sections: a general market information section and a technology section. The general market section was based on applying the People-Place-Information trichotomy (PPI) from information grounds research (Fisher et al. 2006) in a potentially new information ground. The PPI was derived from a large scale study into the information behaviours of university students, resulting in the characteristics of information grounds being discovered, distilled and grouped together into the three interlinked categories of People, Place, and Information.

Information grounds (originally presented in Section 2.4) were chosen as the theoretical underpinning at this stage for a variety of reasons. Primarily, they are simple concept to understand, which the researcher felt would aid in understanding the space. Many different frameworks that can be applied to public spaces are quite theory-heavy and can lead a researcher to getting bogged down in slavishly following a onerous framework. Secondly, one of the goals behind the creation of the the PPI was as *"a first step at organizing information ground attributes for the purpose of informing system design and optimizing information ground settings"*. Finally, this research initially began looking at public spaces as an extension of information grounds, not a separate concept, resulting in the researcher having a greater understanding of information grounds than many other theories. As such information grounds and the PPI were seen as a good choice as a starting block for this stage of the research.

The PPI was adapted into a survey by taking the core characteristics and asking questions about them. Some characteristics could be derived through observation without needing to ask the survey participants any

questions, such as the number of people in the space or the membership type being open to the general public as opposed to closed.

The second section of the survey focussed on technology use at the market. This was in response to the lack of understanding around how technology is being used in public spaces, and in particular, to fill in the gap in the PPI itself which, despite mentioning how technology is becoming part of information grounds, does not discuss technology within the trichotomy itself (Fisher et al. 2006). The questions were quite broad, focussing on what, if any, technology is being used while at the market and if so for what purposes. There was also a minor focus on the use of technology to document and share the market experience, based on previous research showing that there is a desire to do so in similar environments (Lee et al. 2008, Nugent and Lueg 2010).

Both sections of the survey used short answer questions *"did you go to the market alone?"* and more long form open questions *"why did you visit the market?"* and the survey took approximately 10 minutes to complete.

4.2.3 Interviews

The interviews were designed to be a follow on from the survey, taking the information gained from the initial look into the space to help guide the interview in a semi-structured nature. Semi-structured interviews were chosen over conversations for two reasons. First, the findings from the survey (Section 4.3.1) revealed focal points for the interviews. Secondly, the researcher did not feel comfortable talking to strangers without some form of guidance to kickstart the discussion.

The focal points used as guides to the discussion were as follows:

- Motivations and reasons for attending the market.

- Phone use at the market.
- Navigation attempts at the market.
- Sharing while at the market.
- Other technology use while at the market.

While the interviews were still open to additional discussion that fell outside of these points, these were used in the early stages to help guide and start the conversations.

4.2.4 Observation

The final data collection tool used in this phase of the research was observation. The researcher observed what was occurring at the market and stated what they saw into an audio recorder. The observations were intended to be used to support the survey and interviews findings as well as to provide a different snapshot into the market than either the survey or semi-structured interviews could provide. As will be discussed in Section 4.2.6, the audio recordings failed to record correctly and the observations were not used.

4.2.5 Data analysis

When it came time to analyse the data from the survey and interviews, this work followed the approach discussed in Section 3.4.6. The remainder of this section will discuss how the data collected during the research was analysed using a grounded approach, covering the three steps used in this phase of the research: data familiarisation, data coding, and finally, the grouping of the codes into themes.

Data familiarisation

The first step was data familiarisation, in which the researcher immerses themselves in the data. In the case of this work, as the data was all in textual form the author extensively read, and then re-read multiple times, the results of the survey and the transcripts of the interviews over a period of a week following the conclusion of the data collection. During this process some simple notes were taken based on the author's thoughts on the interview and survey data. No coding took place during this period. Once the author felt that the data was sufficiently familiar the next phase, coding, was undertaken.

Data coding

The next step was to form the codes themselves from the data. As stated in Section 3.5.6, the process of creating the codes was iterative. The data from both the survey and the interview were reviewed, with repeated and important terms being identified and marked up as a code. Figure 4.4 shows

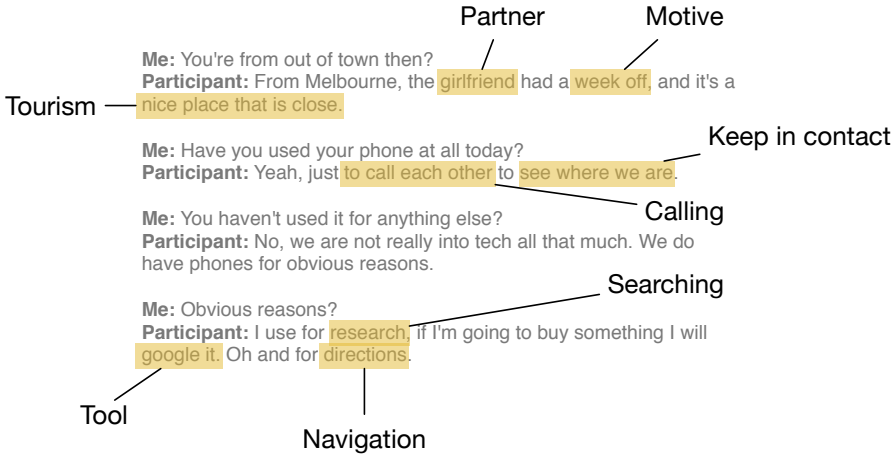


Figure 4.4: An example of the coding process

an example of how the codes were created from the raw data.

Data themes

The final step in the data analysis was to create themes from the codes. After the initial set of codes was identified, the individual codes were then grouped together by their similarity which each other. These groups of codes became the themes (discussed in Sections 4.3.1 and 4.3.2). The themes from the survey were used to create the focal points for the interviews, and the themes from the interview form the basis of the discussion of how technology is being used in marketplaces.

4.2.6 Challenges

The greatest challenge faced during this phase of the research was getting people to participate in the different stages. Any study relying on people willingly giving up their time is bound to have some issues recruiting people. During the survey stage the research was initially performed solely by the author, resulting in far too few people participating for the phase to be completed in any meaningful timeframe. To mitigate this issue, additional researchers were recruited to increase the amount of participants in the study. The additional researchers were fellow PhD students from the University of Tasmania's School of Engineering and ICT. This approach to increasing participation was repeated during the interview stage of the work, mitigating that challenge in this stage of the research.

There were also cultural differences encountered between the Australian and American participants, again resulting in participation issues. As the interviews were performed at markets which span a third of the Earth's circumference, some quirks were expected. It was not, however, people's behavioural differences at the market that caused issue. At the Portland Sat-

urday Markets, many potential participants were perturbed by the requirement of the participation consent form requiring a signature, resulting in many people withdrawing before participating. This signature aversion was not seen in either of the Australian markets and may well reflect the legal and cultural uses of a signature between the two countries (although there is no time available in this work to investigate this phenomenon further). No effective means of countering this challenge was discovered, and was resolved by the researchers asking more people to participate.

The final challenge encountered was with the audio recordings of the market observation. The audio was captured into the researcher's phone via a set of headphones with a built-in microphone. When it came time to analyse and use the observational data, it was discovered that the audio was garbled and unintelligible. The reasons for this are still not clear but the researcher assumes that the headphones had a damaged cable. The side-effect of this is that the observational data contained within was lost and hence could not be used in this phase of the research.

4.3 Findings

This section will discuss the findings of this phase of research, first presenting the findings from the survey and then findings from the semi-structured interviews.

4.3.1 Survey findings

The findings from the survey can be broadly broken down into three different groupings: motivations for attending the market, navigation and information topics, and additional uses of technology.

Motivations

People are attending the markets for a wide variety of reasons. The three main groupings of reasons why people attended the market are: products, experience, and because of others. Food in particular was a very large part of the market, with people attending either to buy food not commonly available, such as fresh vegetables, or for consumption whilst at the market. Food was grouped together with other product related reasons such as looking for gifts or buying items or services that are exclusively available at the market, such as wood. People also attended the markets simply for the experience of attending the markets, with some people being Hobart area locals who had simply not yet visited *"their local market"* and wished to do so. Others were tourists, with some people attending as part of an arranged tour group or attending as tourists because of local residents who were acting in a similar capacity as a tour guide, or attending as tourists of their own design.

There was also a number of people who were attending the markets purely because of others. These unwilling attendees had many of the same characteristics of people involved in a hostage information ground (Fisher et al. 2006), that is to say people who were forced into the market place and participated unwillingly because of others. The groups containing unwilling participants also had similarities to the Tolmie, Benford, Greenhalgh, Rodden and Reeves (2014) study into group behaviour at museums, where people would end up performing the different roles and falling into one of two categories: either those who had to *herd* the unwilling people around the market, or those who were lagging behind. These people were not really participating in the marketplace wherever possible.

The reasons for attending the market parallels many of the topics people were discussing whilst at the market. Products, and again food, were a

very large part of what people were discussing. There was also, however, a large portion of what was categorised as chit-chat, general conversation topics having nothing to do with the market itself, such as politics or their social activities, as well as activities that had a market focus, such as why they visited the market. Finally, people also discussed logistical topics, such as upcoming plans, arranging to meet people, or market navigation.

Information and navigation

Navigation was itself a very common theme amongst people in the market, both navigating to and from the market and through the market place itself. People used both technology and other market attendees as ways of gaining information about navigating. Navigation came across as a negative aspect of the market, a problem to be solved. When participants would talk about navigation it was in frustration. Navigation was a solution to a task, such as identifying a particular stall or item at the market.

The frustration itself was linked to the tools being used for solving the information seeking woes. People were using a variety of techniques including maps, Facebook (Facebook, Inc. 2016a), Yelp (Yelp, Inc. 2016), and general internet searches to find what they were after and were often coming up blank, leading back to the frustration that was observed. As with navigation, people also attempted to use technology to arrange their activities while at the markets. This was attempted, again like navigation, through a variety of different techniques involving already existing platforms to which they had access, such as SMS or Facebook. Once more, as with navigation, this was not observed to be a successful activity and was something participants struggled to achieve with their available technology.

Technology and sharing

Outside of navigation and arranging activities, people used technology to gain additional information about the market itself. This was done through a variety of different existing services such as social networks like Facebook or Twitter (Twitter, Inc. 2016) but also more specialised services such as Yelp. What information the people were looking for ranged from the already mentioned navigation assistance as well as general information about the market and the stalls within. The actual technology they used was primarily smartphones (both Android and iOS) as well as some people with digital cameras and even iPad tablets.

The final, and very likely most prominent, use of technology at the marketplace was for documenting and sharing the market experience. Almost every person who used technology while at the market used it to document their experience in some way. The ways in which people documented their experiences were through photos, notes, and even maps. These were then often shared through a variety of different platforms, with Facebook and Instagram being two of the more spoken about platforms, but people also used Tumblr, Twitter, email, and blogs to share their experiences.

The different platforms allowed people to share their experiences with both people who were at the market and those who were not. Not everyone who documented their market experience, however, shared it while at the market. Some people had no intention of sharing it with anyone, while other people were intending to share the experience at a later date.

People at the market also expressed a desire to interact more with other market attendees, but felt that there was no good way of doing so, as other than with stall holders there was no acceptable way of bridging the social gap. This was not a universal concept. Some people had absolutely no desire to talk to anyone at the market: they had gone for a purpose and

wished to complete it as efficiently as possible, or just did not want to be interrupted in their wanderings. If they wanted to talk to someone at the market, they would.

PPI and and the Salamanca Markets

While this research is not looking solely at public spaces as information grounds, the PPI was used as the structure to help guide this stage of this phase of the research. As such it is worthwhile to show the PPI characteristics of the Salamanca Markets and how they relate to those from the study that created the trichotomy (Fisher et al. 2006). This section will first discuss the people aspects, then the place aspects, and finally the information components of the market.

The people characteristics are grouped into five categories: membership size, membership type, familiarity, roles, and motivation. The Salamanca Markets have a very large membership size, well into the hundreds of people. This is quite different from the information grounds studied previously, with the almost half those studied having a membership size between 2–10 people. The membership type of the market matches with the majority of those Fisher et al. (2006) found, being fully open with no exclusive areas of the market.

The markets have a rather interesting break down of familiarity. Due to its weekly nature it cannot ever match the most common characteristic identified of daily visits to the ground. In general people at the markets fell into a few different clusters, those who visit regularly–either each week or almost each week–and those who rarely visit or have only visited once.

Salamanca Markets have a few different roles amongst its members: stallholder (which is in somewhat equivalent to the PPI role of staff), regular, and new visitor (both of which do not map very well to any identified

role in the PPI). Interestingly, in the PPI study the role of information giver was seen as separate from the others but in the market place almost everyone other those who attended reluctantly had the role of information giver.

Finally, the people's motivation for attending the market is not well understood, but under the loose guidelines from the PPI of voluntary and involuntary there is a mix of both with the majority being voluntary participants in the market information ground. Those who are involuntary, or as Fisher et al. (2006) called them *hostage*, are those who came to the market because another person, such as a spouse, brought them along. The stallholders could also be classified as hostage participants but this was not able to be determined from the information gathered during this study.

The place characteristics are: focal activities, conviviality, creature comforts, location and permanence, privacy, and ambient noise. Salamanca Markets has a diverse amount of activities and stalls ranging from food, fresh produce, local spirits, arts, and tourism souvenirs. All were listed as activities which drew people to the market, with food in particular standing out as very popular component of the market. Other than food, the market itself as a tourist experience was the second most mentioned focal point for people attending.

The market does not have a unified convivial atmosphere. It is a public space, has a rather large amount of foot traffic, and each week a large number of the people will be new. The market isn't conducive to creating a hugely convivial atmosphere. Despite this, though, the casual nature of the market as an experience does mean most people were very willing to start conversations with other people at the market.

The outdoor nature of the market means there are little in the way of creature comforts. There is some public seating but the majority of the market setup assumes a person will be walking through the market at all

times. The fact that the market is outdoors also means all people are fully exposed to the weather. Overall the creature comfort level of the market is quite low.

In a similar vein to the creature comforts, the privacy and ambient noises of the market are quite poor. Being an outdoor public space and major tourism attraction means there is very little that isn't in full view of everyone else attending the market. The open nature also results in the ambient noise levels being quite high. This loud and public nature of the market might well be to its advantage, allowing for more open conversations to form, as proposed by Fisher et al. (2006).

The final piece of the trichotomy, information, is grouped into: significance, frequency of discussion, creation and sharing, and topics. The significance of the information was not entirely clear. From talking to survey participants and looking at the topics discussed, the majority of the information falls into the trivial or small categories of significance. Compare this to the original study into the PPI, small and trivial decisions only made up 40% of the decisions made with the information gathered.

The frequency of discussion was quite low, market participants did not often start conversations with those around them. The large variety of different topics covered and high level of new people at the market means most topics and their repetition was for the most part low. Much like the original study in the PPI, most of the information was created and shared through conversation, both directed and overheard. Unlike the original study, however, there was also a great deal of technology use both to create information, or at least to discover already existing information, and to share it. The technological sharing was performed through a variety of different means, but mostly via social media and instant messaging platforms.

Finally the information topics at the market were mostly topics of general conversation, primarily about the market itself and the surrounding area and events. The information topics were also primarily short term such as the weather or the stalls' goods. In this respect, the market topics are very closely related to the original study into the PPI, revealing most information ground topics are for short term information that is based on immediate needs.

Based on these differences between characteristics of the Salamanca Markets—and presumably all or most outdoor markets—and the information grounds identified by Fisher et al. (2006), it might be fair to say that the Salamanca Markets are *not* an information ground. There is a very large membership size, quite minimal social roles, and the information topics generally fall much more into the trivial category than other information grounds.

Despite this the space does possess very heavy similarities to the previously identified PPI characteristics. The membership is very open, the amount of conversation is quite high, and despite minimal creature comforts and permanence the space encourages conversation amongst its participants. These are all characteristics identified as common in information grounds. The market may not match up perfectly with previously studied information grounds, but through attempting to identify the PPI components within the market it is safe to say that the space definitely matches the original definition of an information ground:

> *"synergistic environments temporarily created when people come together for a singular purpose but from whose behaviour emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information."*
>
> **(Fisher et al. 2005, p.1)**

4.3.2 Interview findings

The findings from the interviews are collected together into four main themes:

- Information seeking.
- Meeting and keeping in contact with people.
- Photos and sharing the experience.
- Frustration.

These codes were derived from data following the coding process described in Section 4.2.5, and the themes are all closely interconnected and mingled. When participants were discussing their use of technology, their discussions and thoughts were not as clearly separated in their mind as these themes. The majority of this section relates to the 14 interview participants who were not stallholders. This section of the chapter will conclude with the unique findings from the stallholders and how these and the other themes lead into the design personas presented in Section 4.4.

Information seeking

Information seeking was one of the most common activities for which people used their devices while at the market. Of the 14 non-stallholder interview participants, nine of them discussed using their phones or tablets for information seeking in one form or another. This section will discuss the information seeking topics, market navigation, the use of information pre- and post-visiting, and finally the tools used as part of the information seeking.

One of the more common goals behind seeking information was in relation to a participant's current market activities. For example one participant who was at the Salamanca Markets for pies and used their phone to

search to see whether any of the stalls sold pies. Other participants would use their devices to try to get additional information on specific items they identified at the market: *"I use it for research, if I'm going to buy something [at the market] I will Google it"*. Another participant, this time from the QVM, used her phone to see which stalls would be open and where these stalls would be located in the market space on the day she visited. She noted that without the ability to check the position of the market stalls on her phone, *"it would be difficult to get around"*.

Participants would also perform general market searches, attempting to find out what was recommended by other people as worth seeing and experiencing at the market. There was also additional non-market information seeking use of their devices while at the market, such as one participant who used their device to check the news.

Navigation was another common information seeking goal while at the market, with half the participants mentioning using mapping and location services as a part of their market experience. Navigating as part of the markets included both navigating to and from the market itself, as well as navigating while at the market. When navigating at the market itself it was generally either to find a specific location—such as a stall—or to join up with another person (discussed further in Section 4.3.2). When using mapping applications–which are by design intended for vehicle navigation use, some participants would instead use the map to help orient themselves relative to the market before continuing.

People also mentioned using their devices before, or en route to, the markets: *"I sometimes research the place I'm going, but not always"* or *"I did a bit of research on the market, time but not location, a few basic details"*. Others would seek information during lulls in their market experience: *"when we sat down to have a coffee"*. Participants would even review their experience

after attending the market: *"take a picture of what I'm interested and will look it up later"*. This behaviour shows similarities to the behaviour observed by Brown and Chalmers's (2003) study into tourism and their discovery of the pre- and post-visiting effect, that is that both preparing for (pre-visiting) and later reflecting upon (post-visiting) a tourism activity is a large and important part of the total tourism experience. That this behaviour was identified at the markets is not unsurprising; all three markets are popular tourist attractions for their respective cities.

Finally, a variety of different tools were used by participants while seeking information. The most common was web search engines such as Google and browsing websites dedicated to the market. Social networking sites, in particular Facebook, were mentioned as ways people both kept in touch with others and as a means to gather recommendations as to what to see while at the market. Alongside social network recommendations, dedicated recommendation tools like Yelp were also used to give people a means of discovering what was worth experiencing. While navigating, both the Google (Google, Inc. 2009) and Apple Maps (Apple Inc. 2016a) applications were mentioned by participants. Despite the large abundance of technological means to seek information, participants would still simply ask another market attendee or stallholder for information about the market. This may be due to people's frustration with the technological tools, as discussed further in Section 4.3.2.

Meeting and keeping in contact with people

People are inherently social beings, so it is no surprise that people used mobile technology to meet up with other people. Only two of the participants *did not* use technology either to meet up with people or to keep in contact with them.

The primary means in which people kept in contact with one another was through instant messaging services, with SMS, iMessage (Apple, Inc. 2016b), and WhatsApp (Facebook, Inc. 2016c) being mentioned by eight of the participants. People using their phones as an actual phone was only mentioned by two participants, however it is quite likely the actual usage is higher than that as a number of people at all three markets were seen talking into their phones. Beside instant messaging, social networking tools were also used both to meet and to keep in contact with people. The multipurpose Facebook and Path (KAKAO Inc 2016), as well as the more specifically locative social media applications Tinder (InterActiveCorp 2015) and Find my Friends (Apple, Inc. 2015), were all mentioned by participants.

Much like with information seeking and navigation, technology's capability to meet up and keep in contact with people was often described as frustrating, discussed further in Section 4.3.2. Some participants, however, were taking advantage of the technology to explore the market in ways not traditionally possible by splitting up and using technology to keep aware of each other and meet up later. One participant used the Find my Friends service to keep an eye on her daughter and also used it later in the day to rejoin her daughter. Another participant who had attended the market with friends had lost track of them, *"they stopped but I kept walking"*, and was able to use Facebook *"to get in touch with someone I've lost"*. Another participant had arranged to meet with people at the market at some point in the future and used the Path social networking application to share her location with her friends when she was ready to meet.

One participant used her phone for *"keeping in contact with my husband"* after she intentionally left him behind while she continued on at her own pace, knowing that *"he isn't a great market person"*. This approach is common enough that the nearby pubs have taken up the concept, an example

of this can be seen in Figure 4.5. She had arranged to meet up with him later, allowing them to both enjoy the market in their own way.

This dynamic movement behaviour of people in groups shows similarities with and also a stark difference to parents sacrificing their own interests at a museum to keep the family group cohesive (Tolmie et al. 2014). The differences at the market simply may be due to the museum study investigating families with children, whereas most of the people interviewed at the market consisted of adults. When dealing with minors, parents are understandably willing to give up their own enjoyment to keep the children together.

Figure 4.5: A pub at Salamanca targeting the hostage participants

Though the majority of participants who attended the market or later met up with other people were doing so with people who were pre-existing members of their social networks. Three participants used technology to meet new people at the market using the dedicated matchmaking social

network application Tinder. How successful these encounters were, or whether they even took place, was not explored as part of the interviews but it is an aspect of public spaces not previously seen. Two additional participants also echoed a desire to use their phones to meet new people but neither knew of any way to do so.

Photos and sharing the experience

The final major use of technology identified at the market was documenting and sharing the experience, primarily through photography. While photography was not the only way people would document their experience it was by far the most common with seven of the interview participants taking photos while part of the market. The amount of photos that people took was quite varied, with one participant taking and sharing photos *"constantly"*, another had taking and sharing photos *"three or four times already"*, but another participant describing the frequency of their photography and sharing as *"very occasionally"*.

The reasons why people took photos was not consistent. Each participant seemed to have their own reasons for taking and sharing photos. Two participants took photos for retention purposes and one took photos of stallholders business cards instead of taking the physical card. Another took photos of the market to *"draw them at home later"*. This participant was also the only one who mentioned taking photos without mentioning any intention to share the photo. One participant from the Portland Saturday Markets was on his wedding anniversary and had been asked to take specific photos of the market to be sent to his in-laws. There was a very strong compulsion amongst the participants to take and share their experience, almost as if it were a responsibility, with one participant saying *"I haven't taken any photos, oh no I haven't! I suppose I should have"*. This participant,

an interstate visitor to the Salamanca Markets, did say *"I guess I have been sharing information about what I've been doing with the family but I haven't at the market"* when asked if they had been sharing photos elsewhere while on their trip.

The tools used to share were again social network systems, with Facebook and the dedicated photo sharing social network Instagram (Facebook, Inc. 2016b) being mentioned. Instant messaging was also popular, with the participants using both iMessage and MMS. Interestingly, when talking about photos and sharing them, unlike other times when talking about their technology, participants didn't seem to have any real complaints about the services. It would seem the taking and sharing photos aspects of experiencing a market are working well.

Frustration

Frustration was the single most common aspect when people spoke about technology. Every aspect of mobile technology use except taking photos and sharing them was mentioned in frustration.

When it came to navigating through the market, every participant was frustrated with how poorly the map-centric aspects of location services translated to the market environment. One participant was able to use the phone's map to find the market but was then unable to find any place to park via the map application. Another participant described their experience trying to use their phone's maps to move about the market as *"[We] find it difficult to get a good understanding of the space from [the] phone, have to use paper map, [we] would prefer to use phone since it's glued to our hands anyway"*. Another participant described the maps as *"not useful for actually getting around or finding stuff to look at"*, or as a third participant far more bluntly put it *"It's useless for that"*.

General market searches were also criticised as poor, with one participant describing her experience as *"[I] wish there was a way to find the stalls or see what locals recommended. Things like Yelp don't really cut it for a marketplace type environment"* and then later in the interview, the far more direct *"Yelp is useless"*. Another participant, new to the Salamanca Markets, described her trouble getting market information from the stallholders *"they're busy or surly looking"*, preferring instead *"to learn about them with my phone but there's no way to do that"*. A Salamanca Markets regular was also frustrated by the lack of information on the changes in the market, in particular what was and was not for sale from the vendors: *"I can't find specials at the market"*. Later during the interview, a costumed zombie march started in the vicinity of the market and the participant was again annoyed that she hadn't been informed, expressing a desire to have participated: *"why can't it tell me, surely my phone knows I go to the market every week?"* A similar experience was also voiced by another market regular *"[I] would like to know where someone has a special sale"*, another market regular didn't even bother using their phone to find information *"I know the market better than it"*. The frustration with technology's inability to procure the information people desired generally resulted in people simply giving up on technology: *"I tried to find pie shops in the market with my phone but couldn't find anything, so I ended up asking a local who I met wandering the market and he told me where to get pies"*. Another participant shared a similar view bluntly stating *"there is no useful way to find stalls or people"*.

Finally, meeting up and keeping in contact with people was not free from complaint. One participant was visiting the market with her family, including children, and had trouble finding her teenage children *"when they go missing at places like the market"*. Another participant felt that her technology ought to be doing a better job of informing her when her friends

were at the market *"as they all live up in [distant place] and come down to the market most weeks but don't always remember to tell me when they're there"*. A third participant lost track of their friends with whom they had attended the market and felt unable to find them after the group split up: *"Don't know where they got to, hard to keep track of them"*.

Stallholders

Stallholders perform a very different role to general visitors at the market place. As such, the findings from the interviews from the stallholders are presented separately from the rest of the study. All the stallholders interviewed came from the Salamanca Markets. For the most part, the stallholders are based at a single location and are working, and as such they have little need of technology to navigate or for meeting up with people. The primary use of technology amongst the stallholders was to keep in contact in their main business location with their and employers. Stallholders also used their technology for keeping in contact with people outside of their work goals, or as one stallholder put it *"social arrangements"*.

Outside of keeping in contact, stallholders also use technology to help people at the market–such as looking up import-and-export regulations or the weather forecast–essentially taking over the role of the phone for seeking information. Finally, stallholders also used the social network service Facebook as a means of engaging with people both at the market and not at the market.

4.4 Personas

This section presents the personas derived from the analysis of the participants in this phase of the work. These personas represent composite

archetypes of the market attendees and will be used to help guide the next stage of the work. These four personas will be used in the next stages of the work as a guide for any technological intervention. Design decisions will be made based on these personas and on the comments by the participants.

4.4.1 Regular Richard

Richard is a market regular, he attends not-quite but nearly every weekend, and he has a purpose each and every time. Today he is here to get some fresh vegetables and then has plans to meet a friend for a drink, at the correct time and the correct place—it was planned in advance and Richard is always punctual. He hasn't abandoned the experience of simply enjoying the market but he has optimised it. As he moves through the market place he doesn't talk to many people, he waves at friends and has quick chats with his regular stallholders but he's here on a mission and enjoying the social experience is only part of it. Richard isn't anti-social and enjoys talking with people as he moves through the market but he won't start the conversations. He asks the occasional question of the stallholders as he searches, looking for the best goods, but he doesn't ask too many or bother wasting his time looking for additional information on the internet. He knows the market far better than any computer!

He does take the occasional photo as he wanders about—after all the market is never exactly the same—but he takes them for himself. If people want to see the market Richard believes they should actually ***see*** the market. As Richard waits for his friend, who is running late again, he wishes he could see what's taking him so long. Eventually overwhelmed by boredom, Richard

calls his friend. Richard rather likes his phone–it takes impressive photos and makes calls–and accordingly it spends most of its life where it belongs: in Richard's pocket.

Richard is based on many of the regular market attendees who often had a very particular reason for visiting the market: shopping or specifically in one couple's case for the local farmers' vegetables they collect every week. The slightly anti-social aspect of Richard comes from the market regulars being just that, regular. The experience of the market is just part of their lives and they have a routine, such as one attendee who effectively trained certain stallholders to shout out at her if they had any specials so she would not need to ask. Richard's lack of desire to use technology is based primarily on two different market regulars: one who, when asked whether he had been using his phone at the market, replied *"Just to read some news, I know the market better than it"* and another who described smartphones as *"offensive and for wankers like [local identity] and those trendy hippies"*. Despite this disdain for technology the smartphone hater also used an iPad at the market and took numerous photos with it while walking around the market. Other aspects of Richard are based on slightly more technology-enthusiastic market attendees, such as one interview participant who would share her location through the Path social networking app, or another who used his phone *"just to call each other to see where we are"*.

4.4.2 Excitable Liz

Liz is visiting from interstate. She and her boyfriend have a long weekend and have decided to visit her sister. Liz has never been to the market before and wants to experience everything: she

wants to see everything, sample everything, talk to everyone, and learn everything she can. Her phone is stuck to her hand like glue. She read up on the market before leaving the hotel. She drove to the market using her phone's maps. She searches for every tidbit she can get as she slowly wanders through the market. Instagram and Facebook are being pinged hard as she pushes every photo she can take into the services and she reads every comment absorbing the suggestions about what to see, what the eat, what to bring back. Her Facebook friends and the market locals seem to know a lot more about the market than the general internet, which is frustrating but nothing a bit of human interaction doesn't fix.

She has no idea where her boyfriend went. He saw something interesting and moved off on his own. A quick look on Facebook and a couple of SMSes later she's up to date with his movements. She's never more than a few seconds away from him; everyone knows what everyone's doing these days. Her sister said she'd be somewhere in the market but finding her isn't easy: there are people everywhere. SMS isn't quick enough and the GPS and maps are useless for getting a point of reference. In the end Liz calls her sister, and of course as soon as she does, turns around "oh there you are" before walking towards her. As usual her sister is walking around with someone new, apparently they just met at the market. Must be time to find the boyfriend and get some lunch.

Liz is an amalgam of numerous different attendees, not all first time visitors but mostly people who rarely visit the market. The heavy use of technology to learn more about the market is common, with Facebook, Yelp, and Google all being mentioned as tools to find information. The inabil-

ity to use these services to find the desired information was possibly the most common issue facing people at the market, with comments ranging from *"very hard to find useful things on [the] internet"* to *"Yelp is useless"*. The solutions to the lack of useful information was generally to ask someone, or as stated earlier by one participant *"I tried to find pie shops in the market with my phone but couldn't find anything, so I ended up asking a local who I met wandering the market and he told me where to get pies"*.

The splitting up and meeting up with people at the markets was another common aspect, with one couple using Find My Friends after their daughter went wandering, or a mother who would let her children go at their own pace through the market. The means of linking back up included Facebook, SMS, phone calls, and Find My Friends. Meeting people wasn't limited to existing social contacts: Tinder was mentioned by three different participants as a tool used to meet new people at the market.

4.4.3 Hans the Husband

> Hans isn't at the market because he wants to be here, he's here because he has to be here. He's not a market person. His wife made it pretty clear that she was "not going to the market alone." He's been walking behind her for a while now, occasionally looking at the stalls, occasionally playing with his phone. Hans comments on what she comments on. The invisible wire connects them together: she walks, so does he, she stops, so does he. His wife is driving them through the market, he is just along for the ride.
>
> After a while his wife found a friend and dumped Hans at a cafe while the two of them enjoy the market without him. He's fine with this, a break from all the people is just what he wanted. A flat white and web browsing is all Hans has planned. He still keeps

> in contact with his wife: the occasional SMS lets her know he's ready to leave whenever she wants. After a while it is time to end the day out. His wife wants to meet up, get some afternoon tea nearby, and go home but Hans can't find her. She says she is near a fruit stall but Hans can't find the place. After some back and forth messages, a phone call, and a bit of directionless wandering Hans finds her. Time to get out of here.

Hans is primarily compiled from participants describing the people with whom they went to the markets. The starting and stopping nature of Hans moving through the market was primarily through observation and from the survey data, with people saying they only attended the market because of other people bringing them, as well as one participant stating the reason he attended the market was because *"the girlfriend wanted to come"*. Hans' aspect of being left behind comes from one participant describing her husband in terms of *"he isn't a great market person"* when explaining why they decided to no longer move through the market together. Hans' use of his phone as a tool to stay in contact comes from two different participants, one who said she used her phone for *"keeping in contact with my husband"* and another saying *"just to call each other to see where we are"*.

4.4.4 Working Rochelle

> Rochelle's been here all day. Her boss was here earlier to help set up but then, saying she'd be back later, she ran off back to the distillery leaving Rochelle to staff the stall. Rochelle doesn't really mind; she enjoys the market atmosphere and helping to sell the spirits is part of her job. She likes the product and likes helping people to buy it. Her job is to sell the brand as much as the

product, Rochelle is taking photos and posting updates to the distillery Facebook and Twitter pages. Her phone is her calculator, invoice machine, and contact to the boss to let her know how the stall is going and to ask her to bring some more spirits for sale—the bourbon cask is particularly popular today. Recently people have asked her to send receipts and information about tours to their phone. Don't they know the distillery has a website with all this info? Eventually Rochelle's boss has to return, she really needs a break. Rochelle's breaks aren't really much more than a quick chat with friends, a few messages with her roommate, and a snack before returning to work. Whiskey doesn't sell itself.

Rochelle is based on the three different stallholders interviewed. All three were remarkably similar in their actions and use of technology while at the market. The primary use of technology was as a link to base: keeping in contact with the main store. Otherwise the stallholders didn't do much with technology except look up information for buyers such as export regulations or post information to Facebook. Outside of technology use, the stallholders mostly were fixed to their stalls and breaks were not much more than a chance to organise *"social arrangements"*.

4.5 Summary and next steps

As stated at the start of this chapter, this phase of the work had several goals:

- To validate the research area by exploring:
  - whether mobile technology, such as awareness systems, are in use by the visitors to the marketplaces.

  - what components and features of mobile systems are currently being used by marketplace participants.

- To uncover what areas of mobile awareness functionality (if any) are currently lacking in support, or are currently unsupported, in communal public spaces.

- To gain a better understanding, both specifically related to technology and in general, of the goals and motives of participants of communal public spaces.

This work used two different stages: a quite broad survey based on the information grounds People-Place-Information trichotomy, and a more in-depth semi-structured interview investigating the specifics of technology use in the markets. These two techniques working in conjunction were used to meet the goals of this chapter: the research area has been validated through showing that technology use is rampant in communal public spaces (Section 4.3.1). Section 4.3.2 uncovered the goals behind participants using their mobile technology at the markets. The primary uses of technology were for information seeking (Section 4.3.2), meeting and keeping in contact with people (Section 4.3.2), and for documenting and sharing their market experience (Section 4.3.2). Alongside these three different areas of technology use there was also a great deal of frustration around their use of mobile technology (Section 4.3.2), with many participants desiring that their mobiles could do more for them and do it better than what they currently can. This is despite the easy availability and abundance of mobile technology and the years of research into mobile technology from years past.

Additionally, this phase of the work also created four different personas from the data to help guide the next stages of this work, giving any

technological intervention a grounding in the space itself (Section 4.4). Finally, this phase of the work also presented the market places as an information ground, giving the information grounds research area an additional example of the theory for future researchers to use (Section 4.3.1). As well, it showed that despite mobile technology research being less of a hot topic than it was in years gone by, there is still a great need for more investigation into the topic.

The next step for this work is to take the personas created here, in conjunction with the other findings, and use them in the next stage of the PADR approach: Action Planning and Action Taking. This will involve designing and implementing a technological intervention as well as adding the intervention into the communal public space. This will comprise the majority of the next chapter.

5

Phase Two: Introducing Change

5.1 Introduction

As discussed in Chapter 4, it is evident that mobile technology is quite prevalent in communal public spaces. It was revealed that people are using their mobile technology for a variety of purposes: some for information seeking, others to keep in contact or to create new contacts, and some for photographing, documenting and sharing their experience. Despite this there is also a great deal of frustration around what the participants were able to do as opposed to what they wanted to do. From these high level themes four different personas were created for the purpose of helping to guide this next phase of the work.

With this knowledge in hand the researcher needed to determine the next step for the work to take. Before this work could continue there was a need for an additional exploration step to progress beyond Phase One: the participants from the earlier stage seemed to give their devices more importance than the earlier literature, such as Dey (2001) or Satchell (2008), had suggested. The reasons for this difference is not fully understood. Between the original study and this work 15 years had passed, and seven

years since Satchell's study in 2008. In this time span it is reasonable to assume that peoples' perception and approach to their mobile devices has changed, and this is something that this work needs to understand before advancing. Therefore the first step was to investigate this further. Once this was completed the work could continue.

As this work is following a modified version of the PADR approach from urban informatics, the obvious next step from PADR is the design, creation, and evaluation of an intervention designed to *solve* some or all issues that have been identified in the prior stages. As is expected from a methodological approach designed for a technological discipline, the intervention will generally take the form of an artefact created for the specific purpose. Alternatively, the intervention could be more akin to a social intervention such as in one of the original works using PADR where the intervention was a regular meeting of like-minded people (Bilandzic 2013a).

This is not to say that technological or social interventions are in direct opposition to one another, indeed this is far from the truth. A technological artefact can be built intentionally to encourage social change, or a social intervention can be designed to encourage technological use. The separation presented here exists only as a way of beginning the intervention, as both the technological and the social have their own approaches and challenges. At this point in the work either, or both, forms of the interventions are a valid choice and have to be considered before continuing.

In the case of this work, however, a social intervention is significantly more difficult than the technological. In the aforementioned example by Bilandzic, the number of people involved was quite small, and as such the ability to influence them is quite manageable. An outdoor market, on the other hand, has hundreds to thousands of people involved at any one time, making it quite a bit trickier to have an impact using social intervention.

In addition, the transitory drop in and drop out nature of the market attendees further reduces the amount of time a single person will have to experience any social intervention. Finally, an outdoor market is a large and public space. There are many people involved who would need to sign off before any large scale changes could be made to the space. All of these issues together combine effectively to rule out a social intervention as feasible in the time frame and scope available to this work. Therefore this work must take the approach of introducing a technological artefact to try and introduce a positive change to the market.

5.1.1 Objectives and motivations

The motivations for this phase of the research comes from the findings of Phase One, revealing that there are a variety of people attending markets as well as a variety of uses of mobile technology at the markets. As discussed earlier this stage of the work is focussing on the introduction of a technological artefact to the market to try and impact the place. There are a variety of different approaches that could be taken, each with their own strengths and weaknesses. Hence a primary objective for this stage is to evaluate and understand what potential and impact, positive or negative if any, introducing a technological artefact has on the communal public space. An immediate objective for this stage is to create knowledge for future systems and research to exploit when attempting to investigate and introduce artefacts into communal public spaces

5.1.2 Ethics

This phase of the research was approved for experimentation by the Tasmanian Research Ethics Committee, under reference number **H0014765**.

In addition to formal ethics approval, this research undertook a number of additional precautions:

- At no point were participants encouraged to divulge any personal information that they did not wish to share with the researcher.
- Analysis of the data was carried out only after any identifying information was removed (in this case that meant deleting information after the first pass of the coding).
- Participants were informed they were free to withdraw from the study at any time before their data was anonymised.
- Participants were informed that no judgements were being made about their usage and understanding of the prototype, their activities while at the market, or their general activities by the researchers.
- Participants were informed that despite the device using and tracking their location, after the experiment ended the system was no longer tracking them and the location information was only being used in the context of this research.

5.1.3 Contributions

The goal of this chapter was to explore the impact of introducing a technological artefact into the markets. At the start of this phase of the work, however, it was discovered that there was an unconfirmed observation leading on from the first phase: that mobiles were an important component of the markets. The first step of this phase was to then explore this further, leading to the first contribution of this phase: an insight into the relevance and importance of mobile phones in communal public spaces.

The work then progressed to introducing a technological artefact to impact the space, the artefact that was introduced was intended to alleviate one of the previously identified issues using the result of the first phase of the work, including the personas and the new finding of the relevance of mobiles in conjunction with the PPI to guide it. The prototype solution allowed people to keep in contact easily and to connect with people from their pre-existing social circles. Using a non-spatial approach to presenting location information, the system was well-received by the participants and was heavily used. This chapter shows that a non-spatial approach to sharing location is possible, well-received, and can help alleviate some of the issues around people keeping in contact with others.

The specific goals for this phase of the work are:

- To introduce a technological artefact in an attempt to improve the communal public space for its participants.
- To gain additional insight into the role of mobile technology in communal public spaces through the evaluation of the aforementioned artefact.

5.1.4 Chapter Structure

The remainder of this chapter is structured as follows:

- Section 5.2 presents and discusses the additional follow up component, investigating an unexplored observation from Phase One.
- Sections 5.3 and 5.4 frame this phase of the research and presents the different potential interventions this work could introduce into the space.

- Section 5.5 discusses the design of the experimental component of this phase of the research.
- Section 5.6 describes the prototype artefact created and evaluated in this phase of the research, including the artefact's evolution.
- Section 5.7 discusses the findings from the experimental component of this phase.
- Section 5.8 concludes the chapter and the presentation of this phase of the research.

5.2 Follow up study

The data collected in Phase One showed a trend where people were dependent on their devices while at the markets, even amongst those who did not use their devices while at the market. This was not a fully realised component of Phase One. Despite this, it seemed that the people participating in the communal public space had three main components to their participation: the space itself, themselves and their group, and their devices and the tasks for which they used them. It was decided that the first step of Phase Two would be to investigate the importance of the device further in order to ensure any experiment was correctly embedded into the fabric of the communal public space. This section will cover the purpose, design, and findings of this additional step to the research. The section proceeds as follows:

- Section 5.2.1 discusses the location chosen for this component of the research and the participants who took part.
- Section 5.2.2 describes the data collection tool used, a semi-structured interview, and the analysis of the data collected.

- Section 5.2.3 presents and discusses the findings from this component of the research.

5.2.1 Place and Participants

The space chosen for this additional component of the research was the Salamanca Markets, as discussed in Sections 4.1.2 and 5.5.1. It was chosen solely for its proximity to the researcher's home location.

A total of nine participants took part in this stage of the research. All participants fell into the age brackets of 25–34 or 35–44 and every participant had a phone with them at the market. Four of the participants were locals and the remaining were all from out of town. All participants were recruited at the market directly by the researcher and no specific demographic was targeted.

5.2.2 Interview and Analysis

Interviews were used as the data collection tool for this stage of the research. The interviews were semi-structured with four focal points relating to the participants' use of their mobiles while at the market and the importance of their devices to them in the market environment. The focal points were developed from the findings from Phase One and are as follows:

- The participants use of maps or navigational aids while at the market.
- The participants use of recommendation systems while at the market.
- The participants use of technology to contact people while at the market.

- the importance, or lack thereof, of their mobile devices to the participants while at the market.

While these were focal points for the interview, they did not preclude the exploration of additional topics should they arise. The use of devices for photographing and sharing their experience was not a focal point for this component because unlike the above this use of technology was never presented as frustrating the participants in Phase One.

The data from the interviews was analysed using a grounded approach in the same manner as the group interviews from the experimental part of this chapter. For full details of that approach see Section 5.5.5. The challenges encountered during this component of the research are presented alongside the challenges for the rest of this chapter in Section 5.5.6.

5.2.3 Findings

After the data was analysed three different themes emerged from the data: function, tools, and motive.

Function

The codes relating to the Function theme are those that describe what the participants used their mobile devices for. These are different than the codes within the Motive them, which are those explaining *why* they used their devices. There is, however, overlap.

There were codes related to using the device for contacting people, *will text*, *will phone*, and *need to contact people*. There were also codes relating to navigation at the market and beforehand, for getting to the market and for indicating a direction to explore. Finally, there were activities unrelated to the market itself. In particular, time-keeping was mentioned by two

different participants and taking and sharing photos was also mentioned.

Tools

These are software tools related to the specific systems which were used by the participants while at the markets. The systems fell into a few groupings: social media, instant messaging, and photography.

Social media group relates to people describing visiting social media sites or applications while at the market. Not every participant posted content, some were simply reading what others had posted. The social media applications mentioned were Twitter, Facebook, Snapchat (Snapchat, Inc. 2016), and Instagram.

Instant messaging group refers to the tools participants used when they messaged friends or family. The tools mentioned were iMessage, Facebook Messenger, WhatsApp, and SMS.

The camera grouping refers to the applications people used when taking and occasionally sharing photos while at the market. Applications mentioned by the participants were the built in camera application on their phones, Instagram, and Snapchat.

Despite recommendation systems such as FourSquare or Yelp being mentioned in Phase One, only two participants had used them (specifically Yelp) and both were not locals. Similarly, despite maps being mentioned a great deal in the earlier chapter only three participants mentioned using a map.

There were two additional codes in this theme which do not fit with any of the above. One was a paper map whose existence was discovered by the researcher when the participant responded *"no, [I] prefer a paper map"* when asked whether they had used their phone for navigation. The other was the phone application, that is using the mobile phone to make actual phone

calls.

Motive

This theme relates to *why* people used or in some cases did not use their mobile devices while at the market. This theme has overlap with the Function theme, which dealt with *how* the participants used their devices.

The first motivation for device use came from people who were explicitly *not* using their devices to navigate or to uncover any additional information. These people, when asked "why?" all responded in a similar manner: *"just wandering"*, *"just browsing"*, *"happy to wander"*, *"enjoy wandering"*, or *"destination is not important"*. This wandering sentiment was echoed somewhat by other participants who were more familiar with the market: *"there is no need to use them"* and *"I know my way around"*. People at the market who did use navigational tools did so *"just to get to the market"* and did not use them to navigate through the market space itself.

Similar to the navigation, all but two of of the participants did not use recommendation systems while at the market. One participant, when asked, had *"never heard of them"*. Most, however, stated reasons similar to the reasons for not using maps: it is better to experience the market than be told, *"don't think I need it"*, *"don't feel the need"*, *"exploration is important"*, and the far more negative *"if I like something, I will like it for my reasons, not someone else's"*. The participants who did use recommendation systems did so in a manner closer to browsing than fully trusting: *"brings up restaurants, to know which way I should be going"* and *"for separating the wheat from the chaff"*.

Finally, there were motivations relating the participant's phone itself. When the participants were asked explicitly whether they considered their phone an important part of the market experience, only three replied in the affirmative; the remaining all said it was not an important part of the mar-

ket. Probing further into why this was, the participants were asked why the device was brought to the market with them. The responses showed the participants considered their devices to be an integral part of their lives: *"feel lost without it"*, *"peace of mind"*, *"can't leave without it"*, *"always with it for contact"*, and *"we're all tethered to them in a way"*. One participant, who was a tourist, upon discovering he had no phone connectivity said, *"I don't realise how important it is"*. Another participant said that they had it because they *"need the basics"*, without fully explaining what the basics were, although they did say that they did use their phone for *"time keeping"*, a function mentioned by another participant. All of these comments relate to the desire to be in contact with people, or as one participant said *"I need to contact people"*. Only a single participant said nothing about this addiction to their device and its connectivity, saying *"the market is a social place"* and that they do not use their device there because they want to *"connect with people"*. That participant did still have a mobile phone with them at the market.

Implications

This additional component of the research reiterates the initial assumption that people's devices are now an integral part of the communal public space experience. People are attached to their devices, even if they do not realise that this is the case. Their devices are arguably as formative on the overall experience as the space itself and the people participating in it, albeit to different degrees.

From a practical perspective, the design of any prototype will have to keep in mind these three scaffolds: people, space, and the mobile phone. The previous personas and participant data that lead to their creation will be examined in this light, and the designs of the prototype will have to link

back to these three scaffolds. From this additional component the remainder of the work can continue safely with the knowledge that the device is highly impactful to the experience—as important as the space and people inside of it.

5.3 The problem with solutions

This stage of the work is concerned with the introduction of an intervention in an attempt to improve the place as it currently exists. As was initially conceived, the PADR approach takes the assumption that a problem will exist for the artefact to solve. As stated in Section 3.5, this work does not take that approach and as such the artefact should be fully justified in its existence before being introduced into the environment. The first part of this section is concerned with describing the potential avenues this research can take in light of the main ways it was discovered that people use technology at markets: for information seeking, for maintaining and initiating contact, and for the creation and sharing of photographs. For full details on these themes see Section 4.3. All of these however take the approach that there is a problem to be fixed, the latter part of this section will look at the potential avenues that do not attempt to *solve* a problem in the space.

5.3.1 Information seeking

Information seeking was the first of the different uses of technology. The information sought depended upon the individual and their goals. Information seeking fell into a few different categories: searching for information about the market itself (such as opening hours), searching for information about stalls inside the market (such as do they have particular prod-

ucts), and finally general information not related to the market. Information seeking also included navigation requests.

A common motif running throughout this theme is that of frustration. People were widely annoyed with the availability and range of information they could find easily. This frustration generally was resolved by abandoning their technology and asking people. A great deal of the time, people, it seems, are still a better option than a mobile phone.

Potential Approaches

Information seeking is arguably the largest area of research in the various fields that comprise communal public spaces work. For as long as people have had knowledge, we have desired better ways of creating, storing, and finding it. Previous attempts to *solve* information seeking problems are extremely varied and cover a vast time period: from hundred year old archiving and organisation of books (Dewey 1891), to artificial intelligence assistants that will take care of your needs (Apple 2015), there is a very large amount of work into this field. With all this work into information seeking it would be logical to assume that the problem is mostly solved, and in some respects it is. If this were truly the case, however, why then were people in Phase One having issues while seeking information?

There are two foreseeable reasons for this. First, it may be that the systems that have been developed as part of the many decades of research are not properly applicable to communal public spaces. They might be too rigid in their assumptions of how people work, not allowing for appropriation and adoption by the users (Harrison and Dourish 1996, Carroll et al. 2003). Secondly, it might be that the research being performed would work but it is not being delivered to the people who need to it. This phenomenon, called the Research-Practice Gap, is where the people perform-

ing the research and the people building systems used in the real world are not sufficiently communicating, sharing, and integrating with one another for the results of one group to feed into the others adequately (Sutcliffe 2000). This is not to say that there is some sort of nefarious purpose behind this, merely that the goals of the researchers will not always mesh correctly with those of the practitioners. Unfortunately, the losers in this are the users: the people who would benefit from the combined effort.

With the systems being too rigid to fit the users' needs and a great deal of brilliant work just out of reach of everyday people, very likely the answer lies somewhere in the middle. For these reasons, focussing on the information seeking frustrations at the markets is a lower priority for this work than some of the other potential avenues. Simply put, the communal public space is quite likely too large and messy to design, build, and evaluate an information seeking system that will then be translatable back into the real world in a meaningful way. At least not in the time available to complete this research.

5.3.2 Keeping in contact and meeting

The second of the general themes of technology use relates to people using technology to keep in contact with people at the market, or those soon to be at the market, and for meeting new people while at the market. These are two interconnected themes: one of using technology to keep in contact with people who are known to be at the market, and another of using technology to establish–and then often maintaining–contact. Technology for this purpose covered a variety of different tools, from calling and instant messaging to location sharing services and relationship applications. The desire to use technology most likely stems from people wishing to explore the market in their own way and at their own pace without being im-

pacted by anyone else with whom they were at the market or had plans to meet. Much like with information seeking, this theme had participants discussing the technology in a frustrated way. The technology did not work properly, was not sufficiently accurate enough when needed, or the lack of technological aids restricted people from leaving their group to explore the market at their own pace with confidence they could return. The frustration, however, was mostly restricted to people trying to maintain contact. There was little frustration expressed by people using applications to make new contacts outside of a concern that there were too few people using the applications with whom they could connect.

Potential Approaches

A great deal of work has gone into exploring ways in which people can be physically separated yet stay in contact with each other. As discussed in Section 2.7 there have been many different approaches to keeping people aware of the activities and state of others.

An early attempt at such a system was Active Badge (Want, Hopper, Falcão and Gibbons 1992), which provided a searchable text-based interface allowing people in an office to know where people were or when they had left the office (Want et al. 1992). Relatedly, ActiveMap (McCarthy and Meidel 1999) took the same idea of tracking people inside an office environment but applied the concept to a map, allowing people to see where their fellow employees were instead of simply reading about where they are (McCarthy and Meidel 1999). The map concept has been employed in a variety of different systems, such ActiveCampus which showed how far away a person's classmates and lecturers were on a university campus (Griswold et al. 2004).

More modern systems such as ReGroup (Nugent and Lueg 2010) used

lines on a map to show current and recent past locations, whereas Just-For-Us (Kjeldskov and Paay 2005) clustered people on a map to show hot-spots of activity. Other systems have taken a simpler approach. Connecto returned to the text-based approach but allowed people to control their location (Barkhuus et al. 2008), similar to FourSquare or Google Latitude. Find My Friends, on the other-hand, only shows the single dot on the map representing where the person is currently located (Apple, Inc. 2015).

Despite the differences in design and implementation, all of these have one thing in common: they all require their users to have an understanding of the space to be of any use. This understanding is either implicit–such as Active Badge or Connecto where to extract meaning a user must understand the space and its sizes and layout–or the understanding is explicit, such as in the case of ReGroup or Just-For-Us where a map is used to impart an understanding of the space. In both situations, though, the results require the user to appreciate the space itself to extract meaning. An example of the more abstract approaches to be explored is the Hummingbird (Holmquist et al. 1999), which was a social-proximity application that would alert people when they got close to another with a Hummingbird device.

As mobile devices homogenised and settled on a single design–the slate touch style smartphones–the approaches which require an understanding of the space took over. This is likely is due to the commonality of satellite navigation systems installed into the phones, encouraging a spacial approach to any system designed to keep people in contact with one another. That said, the exact reasons are unknown.

As such there is still a great deal of potential in exploring a system designed to keep in contact with others using a non-spatial-understanding interface. Such a system would in theory allow people to gain an insight

into the activities and location of others without requiring them to also understand the space in which they are currently residing. This will therefore be a priority focal area for this phase of the research.

5.3.3 Photographs and sharing

The final use of technology at markets centred around taking photos while at the market, and, for some people, then sharing these photos. The sharing was to specific people at the market, to specific people not at the market, and to a to wider audience, generally via social networks. Unlike the other identified themes, people mentioned no significant issues or frustration either with the taking of photos or the sharing of the photos with others.

This does not mean that mobile technology has perfected the taking and sharing of photos, merely that the researcher feels that the topic is already well covered in the literature. The research around taking and sharing photos includes understanding the practices involved when sharing images (Crabtree, Rodden and Mariani 2004), the affordances around sharing photos (Lindley and Monk 2006), and even workshops devoted solely to the topic (Lindley, Durrant, Kirk and Taylor 2008). More recently there have been studies into how Instagram (a program used by participants in this research) impacts a museum visit (Weilenmann, Hillman and Jungselius 2013) or algorithmic approaches to understanding what photos will be shared (Hu, Manikonda, Kambhampati et al. 2014). As such, this phase of the research gives this the lowest priority of all the themes.

5.3.4 Other avenues

The above sections explored potential avenues from the approach of fixing a problem. This section is instead interested in avenues that aim to improve

the communal public space and not directly address an issue identified in Phase One.

Improving the aesthetics

The space of the market itself could be improved, all three of the markets investigated in Chapter 4 were very busy environments with stalls close to each other. This arrangement encourages a pattern of constant wandering throughout the space, with little room available for pausing.

This design shares similarities to concerns raised in the urban design fields, around city structure causing anti-social behaviour (Jacobs 1961). Cities lacking in social space is now seen as a sign of poor urban design (Wall and Waterman 2010) and the same could be said of the markets. Options to introduce a change here are somewhat limited in that the majority of the market is not under the researchers control, but work has been done on encouraging behaviour change in busy spaces (Rogers, Hazlewood, Marshall, Dalton and Hertrich 2010) and these could be used as potential starting points.

Improving the connectivity

All of the three markets have limited connectivity, the only connectivity people have with them are their mobile phones and the occasional public wifi. Even this is still disconnected from the perspective of the market, unless they happen to have had contact before the market, people are limited in their connections to each other and the market as a whole.

Part of this ties into the issues discussed in section 5.3.2, but there has also been work done from the perspective of simply getting people to engage more in public spaces. As mentioned in Section 2.7.3 there has been a great deal of work done on engaging communities through technological

means, especially through interactive public displays (discussed in Section 2.8.5).

Improving the space for stallholders

Stallholders occupy an unusual position in the markets, they approach the space and use their mobile technology differently from the attendees. While market attendees generally used their phones as a source of information, a camera, or as a communication device the stallholders used them more as a utility device to make their job easier.

There are two ways this work could approach this area then, attempt to make an improvement solely for the stallholders, or create a system that is designed to connect to both stallholders and attendees but give them different interfaces and functionality. This sort of split systems has been investigated before, particularly in the education domain such as the work done in the ActiveCampus system (Griswold et al. 2004) where lecturers and students had completely different applications that interconnected with one another. Specific systems for outdoor stallholders is very much an open area however, and one well worth this work exploring.

In the next section, this work will discuss the concepts to be potentially expanded out into prototypes for evaluation, based on these avenues.

5.4 Concepts

This section presents the different concepts that could be expanded and then evaluated in the market. The concepts are grouped under the same potential themes discussed earlier, but this is not to say that a concept from one avenue would not have successful in another. They are presented this way for discussion purposes. This list of concepts is by no means exhaus-

tive, these are the options that this work has uncovered based on Phase One and the literature. While ideally all of these concepts would be evaluated, due to the scope (see Section 1.2.2) and constraints upon this work this is not possible.

5.4.1 Information seeking

As discussed above, information seeking was very prevalent in the markets and often associated with frustration, techniques and tools such as search engines were not as successful as simply asking people.

Experts

One concept to try and alleviate this frustration would be to have people within and even externally to the market available to answer questions as experts. These experts could be identified visually in some way, such as a coloured jacket or could be available digitally as was the case in Cityflocks (Bilandzic et al. 2008), or even both. This concept is for the market attendees like Excitable Liz to use, and for people like Regular Richard and Working Rochelle to be some of the experts.

Digital graffiti

Digital graffiti allows people to virtually paint or annotate a physical space in a way that is then visible to others, without physically altering the space itself. Graffiti has been linked to affecting the socio-cultural experience of a place (Ames and Naaman 2007, Iveson 2013, Foth, Tomitsch, Satchell and Haeusler 2015), and being able to tag and annotate markets has been shown in the past to be popular amongst some people (Nugent and Lueg 2010). This concept is for attendees like Excitable Liz to use for information

and for people more like Regular Richard to leave information about the space for others.

Stall tracking

While there are maps of the markets showing people where stalls are, due to the busy nature of outdoor markets these are of less help than they might first seem. This concept would allow participants to identify in advance what stalls they are interested in and alert them when they are nearby. The system could also use the information the attendee has provided to alert them when it has found a nearby stall not on their list that they may wish to explore. This concept is for both attendees like Excitable Liz and for people like Working Rochelle. To a lesser degree it also impacts people like Hans the Husband as it will let them know probable places they can wait to meet back up with their partner.

5.4.2 Keeping in contact and meeting people

As discussed above, keeping in contact and meeting people at the markets was often associated with frustration. The available tools were either not being used or insufficient for the market environment.

People tracker

One of the older and more common uses of location awareness systems is as an artefact that tracks people and lets others know their whereabouts. These have been used and researched before at markets (Nugent and Lueg 2010) as well as in similar environments. Some of the participants in Phase One even mentioned using people trackers with varying degrees of success.

There are two main approaches one dedicated to a market could take, spatial and non-spatial. As was discussed earlier (see Section 5.3.2 the spatial approach has been investigated before with varying degrees of success but the non-spatial remains unexplored. A non-spatial approach could take the form of a compass but instead of pointing north it points to people. This concept is for attendees like Excitable Liz, Hans the Husband, and Regular Richard.

Social meetup system

Some participants in Section 4.3.2 mentioned using tools dedicated to get people to meet one another, such as Tinder (InterActiveCorp 2015). These systems present people in nearby locations as available and willing to meet other people, and such a system could be used in the markets. This concept would be for attendees similar to Excitable Liz.

Social meeting game

Augmented reality games have been successfully used to get people to move about and throughout spaces (Cheok, Goh, Liu, Farbiz, Fong, Teo, Li and Yang 2004, RocketChicken Interactive 2016), a game could then be used to get people to encounter one another in the game. This concept would be similar to other augmented reality games such as CodeRunner (RocketChicken Interactive 2016) or Human Pacman (Cheok et al. 2004) in that people have to move about a space to play the game. Unlike other games, the goal of this one would be to drive the players to encounter each other while at the market. This concept is for attendees similar to Excitable Liz, and to a lesser degree people like Regular Richard.

An anti-social system

Essentially the opposite of the above systems, for market attendees similar to Hans the Husband that do not want to engage with other people, those who want to be left alone. This system would tell the attendee where public seating, quiet shops, and the smallest concentrations of people are located. The system could instead allow the Hans the Husband' of the markets to find their own spaces to lay low and automatically inform their group of their location once they settle down.

5.4.3 Improving the space for stallholders

As discussed above, stallholders occupy an unusual position in the markets, and their technology use is vastly different from the attendees. The tools mentioned by stallholders were not associated with frustration, as such this section will focus more on improving than fixing. All of these concepts are for people similar to Working Rochelle.

Market information posts

Tying into the issues of information seeking this system could allow stallholders to push out information about what interesting or affordable items they are currently offering for sale. This information could be pushed directly to people's phones, be shown on public displays or even use a mailing list. This system could also support points and events of interest that support the market, such as letting people know about an upcoming zombie march through and nearby the markets.

Faster purchasing

All of the markets in this research were quite busy with limited space for people to move freely. This system could allow people to pre-purchase or post-purchase items from stalls hopefully encouraging less waiting time around stalls while trying to purchase items. The system could also take the form of a market wide rollout of contactless payment systems at the markets to speed up transaction times.

5.4.4 Improving the aesthetics of the space

As discussed above, there are ample opportunities to improve the aesthetics and feel of the markets. The concepts presented here are designed with all of the personas in mind, but will likely be of least applicability to Working Rochelle.

Public visualisation of the market

All of the markets discussed in Phase One are busy environments, so visually there is no way for the entire market to be seen from all areas. This concept could use multiple screens spread throughout the markets. These screens could show a variety of different information similar to the public large screen research discussed in Section 2.8.5 or could display live videos of the rest of the market.

Encourage market exploration

Similar to the system discussed above, to get people at the market to encounter others, a game in a similar style to CodeRunners (RocketChicken Interactive 2016) could be created where it encourages people to move about the market. The system could be based upon work done to encour-

age people to take stairs using ambient influences (Rogers et al. 2010). Finally the system could also take the form of a fully physical system, such as cards spread throughout the market for people to collect. All of these concepts to encourage market exploration are for the Excitable Liz type people but also has benefits for the Working Rochelle type people as it can be used to drive attention towards their stalls.

5.4.5 Decisions decisions decisions

In an ideal world all of these concepts would be created, evaluated, and the impact they have on the market presented. As is discussed further in Section 5.5 this work is under numerous different constraints limiting the amount of total available time to evaluate interventions. Due to these constraints it was decided that it would be better to iteratively improve a single concept instead of taking a shallow evaluation of multiple.

The concept chosen to evaluate was the people tracker concept discussed in Section 5.4.2. This concept was chosen over the others for a variety of different reasons:

- The large body of research in related areas (discussed in Section 2.8.4) can be used as guidance.
- The concept directly addresses a frustration discussed by participants, giving a starting point for prototype design and evaluation.
- The researcher has expertise in the domain decreasing time required to begin evaluation of the prototype (Nugent and Lueg 2010).

5.5 Design

This phase of the research is concerned with the evaluation and iterative development of the prototype system (detailed in Section 5.6) designed to aid with the some of the issues that Hans the Husband and Excitable Liz persona market attendees were having, and is guided by the findings that the three scaffolds of the market are the people, their devices, and the space. For a list of materials see Appendix B. The remainder of this section is as follows:

- Section 5.5.1 describes the location chosen for the evaluation.
- Section 5.5.2 is a discussion on the participants who took part in this phase of the research.
- Sections 5.5.3 and 5.5.4 is an analysis of the two data collection tools used, including a usability questionnaire and semi-structured interviews.
- Section 5.5.5 covers the approach taken to analysing the collected data.
- Section 5.5.6 finishes the section by discussing the challenges faced during this phase of the work and how they were overcome.

5.5.1 Salamanca Markets

The space chosen for this phase of the research is the Salamanca Markets. The Salamanca Markets were one of the three markets used in the first phase of this work, and were also the space with the most participants from the earlier phase, making it an ideal choice for this phase. Of the three markets used in the first phase, Salamanca Markets were chosen over the other

two purely due to its proximity to the researcher's location, simplifying access. For more details on the Salamanca Markets see Section 4.1.2.

5.5.2 Participants

A total of 18 people participated in this stage of research; they were members of five different groups. There was one group of two people, one group of three people, two groups of four, and one group of five. In the case of one of the groups of four only three people had access to the prototype, and in the group of five people only three had access to the prototype. In both of these groups, people without access either accompanied the people who did, or else the device was shared amongst the group. Therefore the people who did not have exclusive access to the prototype did still take part in the market experience with the prototype system along with their group. They also took part in the group interview, primarily talking about the experience vicariously.

The participants were from a range of ages. Nine of the participants were in the 45–54 age bracket, six were 25–34, two were 15–24, and one was under 15 years old. 11 of the participants were male and seven were female. Everyone involved had visited the market before participating in the study but none of the participants considered themselves a market regular. Participants were recruited either at the market directly on the day of experimentation or were recruited before through preexisting channels to which the researcher had access. All people were recruited as a group, so any information the prototype collected and shared was between people who were already known to one another.

5.5.3 Usability Questionnaire

The first of the data collection tools used in this phase of the work was a standardised usability questionnaire. This was chosen for a two different reasons. Firstly, although the creation and a usability evaluation of a system is generally no longer seen as a worthy goal in HCI research (Kjeldskov and Paay 2012), the usability of the system has to be considered. For this reason a usability questionnaire was given to the participants to complete after using the prototype and before the group interview. The intention of this was that the feedback would be useful for the next iteration of the prototype. The second reason for the questionnaire was to aid in the interview. The questionnaire acted as an ice-breaker for the upcoming interview, giving the participants and the researchers an opening at which to begin the group interview. The results of the questionnaire were neither expected nor intended to be an outcome for the research, as a fully realised system derived from the prototype is not a meaningful outcome for the research.

5.5.4 Interviews

The second data collection tool in this phase is a semi-structured group interview. As the interview was semi-structured, there were no fixed questions but rather there were a list of focal points to drive the interview. The focal points were the participants' use of the prototype, their normal use of phones while at the market, and how they would normally keep in contact at a market.

The interviews were done as a group because the prototype was designed around the concept of a group using it. As such, the opinions from both the group as well as the opinions of the individuals were sought. The intent was that people would be able to use each other's words and ideas

to generate new thoughts rather than the interviewer eliciting information. This approach arose from the first phase where the researcher observed that when talking to individuals, people from their group would often attempt to interject into the conversation or would confirm certain statements.

Audio recordings were made of the group interviews and the interviews were coded directly from the audio files. This decision was made due to time constraints as it was believed that performing the coding directly would be faster than first transcribing the interviews.

5.5.5 Data analysis

Much like the first phase of the work, this phase takes a grounded approach to analysing the data. Also, much like the first phase, the analysis is broken up into three distinct stages: data familiarisation, data coding, and data themes. Unlike in the first phase of the work, however, in this phase the interview data was analysed live from the audio without an initial transcribing step which presented its own unique challenges and advantages in each of the three stages of the analysis.

The decision to perform the coding directly was made due to time constraints. It was believed that the additional time taken to transcribe the audio would be greater than any extra time added to the coding process by using the audio files directly. For a discussion of the benefits and costs of this approach, see Section 5.5.6.

Data familiarisation

As stated in Section 3.4.6, the first step before any true analysis of the data can begin is for the researcher to be familiar with the data. The intention of this step is so the researcher is fully grounded in the data before they

attempt to extract any codes from it. The purpose of this grounding is not to be a memory aid but to ensure that the researcher has grasped the intricacies of the data. This familiarity will also speed up the coding and allow for better grounded codes. Without this step the codes gleaned very likely would be different from those determined after performing data familiarisation.

In the case of this work, the decision to use live audio meant that the data familiarisation phase worked differently than it normally would when taking a grounded approach. If this work were taking the normal approach, the interview data first would be transcribed. Then the researcher would read and reread the interview data until they felt comfortable with their understanding and familiarity with the data. For this work however, data familiarisation was done by listening to the interview audio multiple times over a period of a week. Each interview was listened to individually in an atomic fashion with no interruptions or pausing of the audio until the interview concluded. The interview audio was listened to at the normal playback speed. Because of this, the data familiarisation stage took longer than it would have taken had the audio been transcribed first. This was seen as an acceptable trade-off to avoid the time and cost associated with transcribing the interviews.

Data coding

After data familiarisation is complete the next step is to extract codes from the data. Much like the first phase of the work, this stage uses an approach based on open coding. The codes were uncovered by listening to the audio and pausing it for notation when certain key phrases or words were reached. As the codes were being created from the audio directly, whenever a particularly interesting phrase was spoken the time stamp for that

phrase was written down next to the code to allow for easier quote retrieval during later stages in the work. This process was repeated for each interview until a list of top level codes were created. These codes were then iteratively refined, with some similar codes being merged together. Creating the codes directly from the audio was expected to slow the process down compared to creating the codes from transcriptions. However, when the coding was undertaken this was discovered to not be the case. The first pass audio coding took only a few minutes longer than the length of the interview to complete, which did not seem significantly slower than a first pass would take with transcribed interviews.

Data themes

The final stage of the data analysis is to create themes from the codes, which allows for capturing higher level abstraction of the data than the individual codes allow. After the coding phase, the numerous different individual codes were grouped together with similar codes into high level themes to provide a high level understanding into how people used the prototype system. These themes form the basis of the discussion and findings of this chapter, and are discussed in Section 5.7.

5.5.6 Challenges

The first challenge encountered in this stage relate to the decisions as to which concept to use as the basis of the technological artefact. Following on from Phase One there were many different approaches available for the work to take. The original intent was to evaluate multiple different concepts, however, due to the time and scope constraints on this work only a single prototype was evaluated.

The research began with the initial premise *that there is an insufficient*

understanding into how technology can support communal public spaces, discussed further in Section 1.2. While evaluating multiple different concepts in the space would improve this understanding, so would gaining an in-depth understanding of how a single concept impacts the space. Each new concept to be evaluated will take more time than iterating over an already established concept. As no research has endless time or resources available to it, a decision was made to instead evaluate a single concept iteratively, to gain the greatest specific insight instead of gaining a large amount of general insight. This challenge therefore was partially resolved, one concept was chosen to be evaluated, however the rest remain solely as concepts. For the reasoning behind the specific concept was chosen over the rest, see Section 5.4.

After settling on a prototype concept, the primary challenge encountered with this stage of the research is the same as the first phase: getting participants. This stage required more from the participants than a simple survey or interview. It took longer to complete and required people to change from their normal market experience. Compounding this issue is that this stage required groups of people to participate, not just individuals, making recruitment more difficult. Where possible the participants were encouraged to use their own devices, but the researcher did have three mobile phones available for participants who did not possess devices capable of running the prototype software. In the case of participants who were using their own mobile devices to run the prototype system, there was a great deal of trust required between the participants and researcher that the prototype was not performing any nefarious tasks. The means of resolving this challenge was simply for the researcher to ask more people to participate and by broadening the means of recruiting, such as through mailing lists instead of solely at the market. This is far from an ideal solu-

tion but because of the exploratory nature of the work this was determined to be sufficient for the completion of this stage of the research.

Going hand in hand with the issue of recruitment were various technological issues. iOS was chosen as the development platform for a variety of different reasons, but this resulted in a series of challenges. The smart phone market in Australia is approximately 40% iOS and 60% Android (Kantar Comtech 2015). As such, many potential participants might not be able to take part in the research due to device incompatibility. Finally, since the researcher also has a great deal of prior experience with the platform (Buttfield-Addison, Manning and Nugent 2014, Manning, Buttfield-Addison and Nugent 2014), it was felt that the time saved developing the prototype system was worth the possible participant loss.

As this was a prototype system it was inevitable that bugs and issues would appear throughout the experiment and while these were rare they did cause their own series of small challenges. In general, any technical issues—often minor bugs—were often resolved in the next iteration of the prototype. Some issues, such as the prototype only running on iOS systems, were not addressed and remains an open issue with the prototype.

Finally, this stage of the research used a new means of analysing the coding the data—directly from the audio recordings. This had never been attempted by the researcher and caused some small issues. Live audio analysis made the initial stage of the coding process, data familiarisation, much slower than it would be for transcribed interviews. Once this step of the analysis was complete, however, the creation of the codes from the recordings went very quickly and seemed to go as quickly as it would normally take to create codes from transcribed data. The downside to the direct audio analysis became apparent when it came time to writing this document. Quotes were significantly harder to extract from the audio than

from a transcript.

Overall, however, the extra time added to the process by performing analysis directly from audio was seen as an acceptable challenge in order to avoid having to use time transcribing the interview data. In an ideal world it might be better to perform the analysis directly from the recordings and then have the interviews transcribed at a leisurely pace to reduce cost and prevent delay in conducting the research. This would allow the researcher to begin analysis immediately but still have a written version available when it came time to write.

5.6 Prototypes

This section presents the prototype system developed for evaluation in this phase of the research. As discussed in Section 5.4.2 this prototype system is based on the findings from the first phase of the work (presented in Section 4.3), the personas of Hans the Husband and Excitable Liz (presented in Section 4.4), and the implications of the importance of mobile devices to communal public spaces (presented in Section 5.2). Based on these, the initial inspiration for the prototype design was that of a compass, but one that points to people instead of to North. For the source code and materials associated with the prototype see Appendix C.

The structure of the remainder of the section is as follows:

- Section 5.6.1 presents and justifies the basic design of the prototypes,
- Section 5.6.2 discusses the mobile platform,
- Sections 5.6.3 to 5.6.5 presents and justifies the three major iterations of the prototype, and
- Section 5.6.6 discusses the technical aspects of the prototype.

5.6.1 Design basis

The basic metaphor behind this system is that of a compass but instead of pointing North, it points to other people. This section will present the justifications for the metaphor based on the mobile HCI literature and the first phase of this work, the impact of the information grounds literature on the prototypes, and the validation of the metaphor before it was expanded out into a prototype system for evaluation.

Using the literature as a starting point, the obvious approach for a social location system would be to create or repurpose a system showing where people are located onto a map of the markets, similar to what was done with Active Map (McCarthy and Meidel 1999), or iSocialize (Andersen et al. 2006). The great advantage of this approach is that once an understanding of the space is captured, the system provides information about where others are as well as where the user is both relative and absolutely to the others in the system, giving a point of reference for all users. The greatest disadvantage with these systems is that they require their users to grasp the spatial aspects of the space to use them, issues that participants of the market mentioned. As such it was decided that a spatial based approach is inappropriate for the markets.

The next step then is to investigate those systems in the literature that took a non-spatial or at least a non-map based approach to sharing location. A system similar to Connecto (Barkhuus et al. 2008) which shared textual representations of locations might be appropriate. While people in the studies did use it for coordination this was done over long periods of time, such as when knowing people were moving from home to work (Barkhuus et al. 2008). The system was most successful at telling social stories that only the group would understand, such as setting locations to

moods or actions. As such it was decided that considering the short lifespan of the markets a system similar to Connecto is inappropriate.

This was seen as a good opportunity to try something untested, a social location system that takes a non-spatial realtime approach. The compass metaphor comes from work into spatial navigation systems such as Bidwell, Lemmon, Roturu and Lueg's (2007) investigation into virtual world wayfinding which used, among other tools, a compass. The compass was added into the system after the first iteration at the request of one of the participants and was discovered that the participants that used the compass did better than those that did not (Bidwell et al. 2007). The work revealed that the compass provided an extrinsic frame of reference, the same functionality that map provides. Work by Brown et al. on mixed reality systems for visiting museums made heavy use of orientation and location of participants as a key shared information source (Brown et al. 2003). This work found that the users exploring the space without the shared location and orientation caused issues for everyone as they appeared to jump and move about the museum in strange ways (Brown et al. 2003). Additionally those virtual visitors who only had a location based map and did not get the shared orientation would issue statements such as *"left"* or *"top"* referring to the map and not the orientation leading to confusion, revealing the importance of orientation in conjunction with location (Brown et al. 2003). Finally comments made by participants in Phase One about using maps, such as *"there is no useful way to find stalls or people"*, and *"not useful for actually getting around or finding stuff to look at"* when taking alongside the heavy use of messaging and social media to keep in contact suggests that a new approach is in order.

Based on the above this work considers that a compass metaphor offers great potential in improving the situation of meeting and keeping in

contact with people. The advantage of the metaphor is it provides a simple and immediate understanding, people are where the arrow is pointing, without requiring any other knowledge or understanding from the participants. The disadvantage of the compass metaphor is it provides no global point of reference for all participants, as such it cannot help navigate through a space or provide an understanding of it.

The basic metaphor was tested in an uncontrolled, wizard-of-oz fashion (Molin 2004) by the researcher with fellow research students being the participants. The intent of this was not to gain useful information about the impact of the concept, but to see if people could grasp the basic metaphor. This showed that the basic metaphor had potential, after which the design, implementation, and evaluation of the prototypes began.

Finally the impact of the information grounds research on the prototype needs to be mentioned, as was discussed in Section 4.3.1 the People-Place-Information trichotomy is not an ideal fit for the market environment, however the information grounds impact on the design of the prototypes should be noted. The original concept of an information ground is that of a place that encourages information sharing through the co-location of the people within the space, even when the goal of the place is not the sharing of information. Essentially by placing people together they will communicate and share. The design of the prototypes kept this at the forefront the entire time. The system and even the basic metaphor does not attempt to help people communicate, it merely attempts to make it easier for them to eventually meet back up. By encouraging and supporting people to dynamically split and meet they will be able to communicate on their own terms. The prototypes do not support sharing information but their very concept matches with information grounds core concept, getting people together will get them talking. The prototypes therefore directly

supports the information grounds of the markets.

5.6.2 Platform

The platform chosen for the prototype was Apple's iOS mobile phone platform. This platform was chosen for a number of reasons. Firstly, at approximately 40% of the Australian and global smartphone market (being slightly higher in Australia than the worldwide average) (Kantar Comtech 2015), it is one of the more common mobile platforms available. Secondly, the platform has a robust and well documented toolset dedicated to the rapid construction of high quality mobile applications. Apple was the first major technology company to bring what is now the common smartphone design to the market and the basic design of the iOS platform has been copied and used as a basis for the majority of the smartphone market. The differences between iOS and the other major smartphone platforms are mostly cosmetic and any results gathered from this phase will be equally applicable to other platforms.

Finally, the researcher has a great deal of previous experience and expertise in the iOS platform. Therefore using this platform will save development time lost learning a new platform's toolset (Buttfield-Addison et al. 2014, Manning et al. 2014).

5.6.3 Initial Prototype

The initial version of the prototype comprised two main views. The first view showed a list of people using the application, the group of people with whom the participant attended at the market. The names that populated the list came from the participant's device name. Tapping on any of the people in the list would take the participant to the second view. This

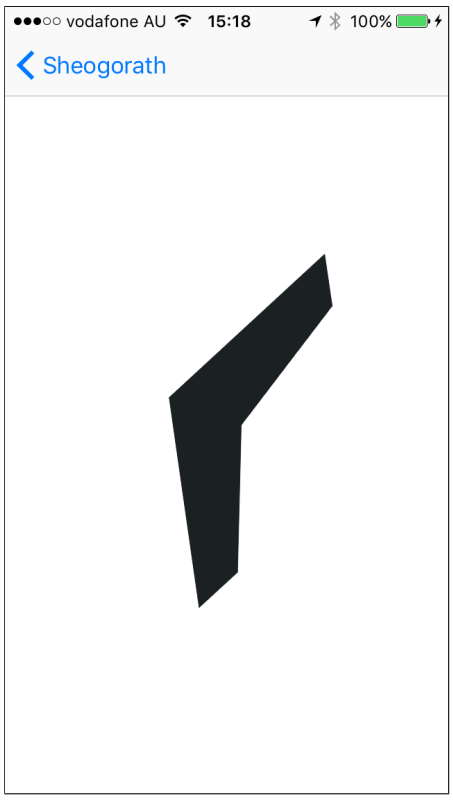


Figure 5.1: The initial iteration of the prototype

view showed a single arrow taking up most of the space on the display, this can be seen in Figure 5.1. The arrow would spin to point toward the direction of the person selected in the first view.

If a participant moved to within 10 metres of the person they were following, the arrow would disappear and a label would appear, taking the arrows place, telling the participant that they were within 10 metres of their quarry. The reason for the disappearance of the arrow in favour of a simple message was due to the limits of the GPS technology being used. The positioning hardware and software of mobile devices, as discovered during early testing, starts to suffer accuracy issues at around 10 metres and the arrow would invariably end up pointing in the wrong direction. As such

it was felt that it would be better to disable the arrow rather than show the participants potentially incorrect information.

Other than when within 10 metres the system was highly accurate and the position the arrow was facing was as accurate as the device hardware allowed. As long as two people were not within 10 metres of each other, following the arrow would guarantee the two would end up meeting with one another. The people in the group who were not the current focus of the app, those that were shown on the first screen described above, were still tracked and their positions still followed. When switching between people the arrow would immediately change facing to their position.

The design of the prototype was based on two main points. First, from the literature, there was already a great deal of work into how spatial systems for finding and keeping in contact with people but far less when it comes to non-spatial systems. Secondly, from this work it was learned that people rarely use systems other than their phone or instant messaging to keep in contact, and those doing so do not find the experience particularly enjoyable.

This design is in keeping with the motives and desires of Excitable Liz and Hans the Husband (see Section 4.4 for the description of the personas). Liz desired easier ways to be able to glance at and be made aware of the status of the rest of the people she attended the market with. Liz was also after an easy way of linking up with her group. Hans did not care about what his wife was doing and had no desire to engage more with his group or the market but did want an easy means to reconnect with them when it was time to leave. The prototype allows for both of these personas desires to be met.

It was therefore felt that any system developed had to be as simple as possible so as to not distract from the market, not require a heavy en-

gagement for usage (as instant messaging and phone calls do), and not require an understanding of the space to be useful. With these criteria in mind, a design based on a compass was chosen to be the initial approach. While there are numerous different potential approaches, a compass was believed to be a good starting point due to its cultural commonality—most people will know what a compass is even if they have not used one. This design has a low level of engagement, a person simply moves in the direction of the arrow to find their quarry. It does not require a spatial understanding to use, left is left and right is right for all of us. If there is an obstacle, people can move around it themselves without having to be routed by a system. Finally, it is simple. The only artefact is the arrow itself and all it can do is point in a direction.

The simplicity was felt to be an important goal based on the comments from the participants in Phase One where they discussed how they would arrange meeting up with others dynamically, less so upon pre-arranged places and times. This was often facilitated through instant messages or phone calls, and far less often through dedicated systems. Due to the frustration encountered by the participants when trying to keep in contact and meet up with their social groups, clearly something is not working as intended. As was discussed in Section 5.6.1 this work has decided to take a non-spatial approach, which is a new approach to this domain, taken in conjunction with the issues around current systems and spatial approaches to exploring the markets causing frustration this work has decided that it is best to create as simple an interface as possible, at least for the first iteration. The arrow compass design encourages glancing at the system and gaining only the most relevant information, which direction someone is relative to the participant to help prevent someone requiring to have spatial knowledge of the market to meet with their group. The appearance of

the arrow itself was based on the people markers from the work done on sharing location and orientation by Brown et al. (2003).

5.6.4 Second Iteration

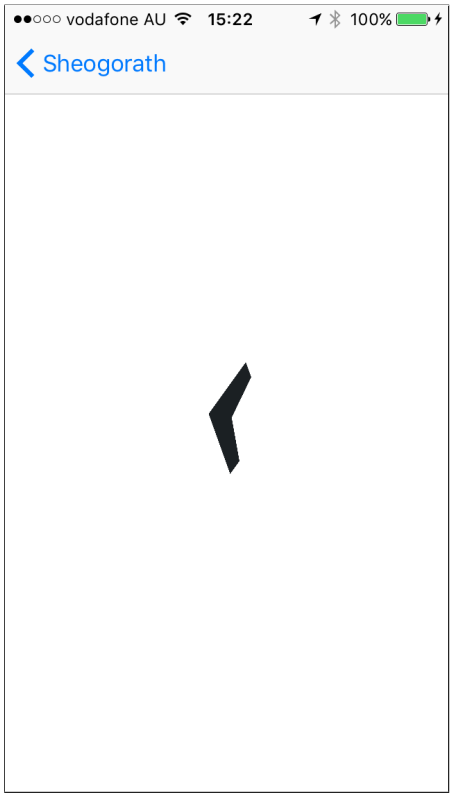


Figure 5.2: The second iteration of the prototype

The second iteration of the prototype was very similar in nature to the first. The prototype acted in exactly the same way: two views, one a list of people and the other an arrow pointing to the selected person. The difference between the first and second iteration is the arrow itself. In this iteration the arrow would grow or shrink based on the distance between the participants. The closer the participants were, the smaller the arrow, this can be seen in Figure 5.2. Other than this change the prototype worked

exactly the same as the first iteration.

The concept of adding a distance component into the prototype was raised in the comments of the participants who used the first iteration. *"I would like a range indicator"*, or from another group *"it should get bigger or [smaller] as you get closer"*.

The specific design of the arrow growing and shrinking based on distance came about, however, from the literature. Resizing-arrows have been used before to indicate distance in software applications (Lehtimäki, Partala, Luimula and Verronen 2008) and previous research has also shown that just showing pure distance as numbers is not immediately understood by people and that change was seen as more useful than just the raw information (Andersen et al. 2006). Initially the intent was for the arrow to distort shape and size to better show that a person is near or far, however due to time constraints required to implement this had to be consigned to a later iteration.

With the addition of a distance capability in the prototype this also helps with the issue the Regular Richard persona was having with their prearranged meetings, wanting to know how long until his friend would be able to meet him. Now the Regular Richard participants can use the system to monitor the people in their groups without having to explicitly engage with the group to gain this information.

5.6.5 Third Iteration

The third iteration was a significant change from the first two. Unlike the first two—which contained two different views, one for selecting which person to follow and one for seeing their direction—the third iteration had a single split view. The top of the screen showed an arrow, the bottom half a list of people. The intent behind this was to allow people to get an

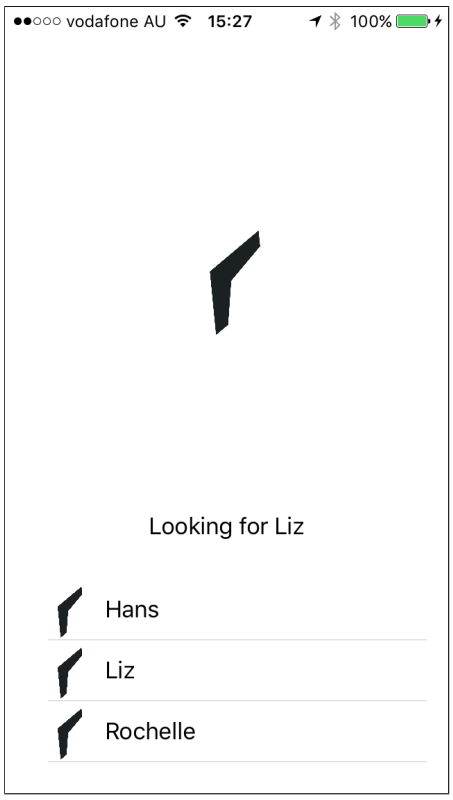


Figure 5.3: The third iteration of the prototype

at a-glance-view of everyone in the group via the list and the main arrow provided detail regarding one specific person.

The list of people was functionally the same as in the first two iterations. Selecting a person would show the arrow for that person. The list of people, however, also showed a smaller arrow next to the name. The smaller arrow was functionally the same as the large main arrow in that it rotated to the direction of the person's location. The large main arrow itself worked as in the second iteration with one small difference: due to a bug in the prototype the arrow would continue to exist even when within 10 metres. The impetus for this iteration came about because of the participants: throughout the first two iterations there were comments about

being able to see the entire group at once. *"I would like to show all the people on one compass"*.

The design itself was more complicated. The initial idea was to have multiple coloured arrows all taking up the prime position and a legend indicating which arrow was for whom, during initial implementation, however, this ended up appearing confusing to the developer. As such it was changed to have small arrows next to the person switcher and to move the switcher onto the main view. The multiple coloured arrows idea still has a great deal of potential and should this work be extended trialling different interfaces is a prime starting point.

5.6.6 Technical details

All iterations of the prototype ran on Apple's iOS platform, specifically versions 7 to 9. The supported hardware for these operating systems are the iPhones 4S, 5, 5C, 5S, 6, 6S, 6+, and 6S+. Of these different devices, the prototype was not run on the iPhone 5C, 6S, and 6S+, although there is no reason to think it would not function as expected.

The prototype used the built-in global navigation positioning system (GPS) to determine the device's current location and the built-in compass to determine current facing of the device. These were combined together using the Riemannian circle mapping (also known as the Great Circle mapping) and the other participants' current locations to determine in which direction to point the arrow.

The prototypes were networked and shared information over the PubNub messaging stream system. As soon as a location or heading update was determined by the device hardware, the prototype would instantly push it out over the network, allowing for effectively real-time communication amongst the devices, restrained only by the latency of the network

and positioning hardware updates.

5.7 Findings

Five different themes emerged from the data following the coding process presented in Section 5.5.5 and all five themes are closely related to one another. The divisions presented here were not as clearly delineated in the participants' minds when they were being interviewed.

The remainder of the section is broken up into explaining the different themes identified from the coding and are presented as follows in no particular order:

- Normal market activity.
- Prototype Use.
- Design.
- Suggestions.
- Privacy.

5.7.1 Normal market activity

The first theme identified from the data analysis related to how people would normally act and use their technology while at market places, both at Salamanca Markets if they'd been before or at similar environments.

The conversation about normal market activity had a heavy focus on how participants handle dealing with a group of people trying to coordinate their movements, partings, and meetings. This is very likely due to having just participated in an experiment with an artefact that can be used for coordination. When arriving at a market with a group, the participants

explained how they would normally split off from the group for a variety of reasons. One participant spoke about how they would intentionally leave their group so that they did not get bored exploring the market with them: *"I usually come here with my family and I don't like hanging around with my family because they are capable of spending 20 minutes examining a sweater"*. Two of the participants, both parents, spoke about how they would let their children run ahead of them to explore the market: *"I'd probably use it more for just checking where [child] is, not to find my child..."*. At which point their partner joined in: *"the kids will nick off if we are at the market, we are happy for them to do it because then you get peace and quiet"*.

Participants' willingness to split the group does come with issues however, relating to how to merge the group back together. Techniques to get around this agree with what was said by participants from the first phase of the research (Chapter 4). The participants would sometimes set a time and place that they agreed to all meet up at. As on participant put it, *"you know something like 'in an hour meet you underneath the clock or at a focal point'"*. Other times they would try to meet up dynamically. Organising a meeting time does have its own issues, and because of this most participants mentioned that they tried to meet back up dynamically. This was done primarily through the participants' phones, either via SMS or iMessage, or by calling the other members of the group. When talking about this topic participants were remarkably similar, all giving near identical responses when discussing how they would normally keep in contact, from the direct *"Phone: 'Where are you?'"* to *"yeah we phone each other, always do"*, the use of phones as, well, *phones* is quite noteworthy. One participant even mentioned that after using the prototype system they noticed just how many people are calling people while at the markets.

5.7.2 Prototype Use

This theme encapsulates the discussion the participants had about their use of the prototype system itself. This generally comprised three main sub-themes: 'monitors', 'glancers', and 'hunters'. These three sub-themes have a very heavy amount of overlap and are broken up mostly for discussion purposes as the participants' discussion about their use of the system flowed through all three themes. As such these three themes should not be thought of in the same way as personas—in which each persona is a silo representing a participant—but more like a mode between which the participant switches depending on their own goals and motivations.

'Monitors' refers to when the participants used the app to be able to see the group, to keep up to date with where people are, and presumably from that be able to determine what the others are currently doing. When using the system for monitoring, participants described using the system specifically for monitoring the group as a whole with one participant stating *"I was continuously stalking everyone"* followed by another member of their group *"I was doing the same"*, or for monitoring specific people, *"I was wandering aimlessly and occasionally checking it going 'I wonder where [participant] is'"* or the parents who used the system to keep an eye on their daughter. Participants monitoring the prototype also described how they could use the system to learn more about their group's activities. They were able to determine location *"it did indicate they were coming from behind me, which was the direction they came from"* and their distance *"the size was good, I knew you were close"* by observing their group through the system.

'Glancers' are those who would check the prototype occasionally. They would glance at the system as they moved about the market but it was not a primary focus of their market experience. When using the prototype as a

glancer, participants talked about the prototype more in conjunction with how it related to what they were doing at the market. One participant talked about using the application *"to find my way back here"* where *here* was where the rest of the group had congregated after they had finished at the market. Another talked about how they would use the prototype in bursts, looking at it, putting it away, moving about the market before reopening the app and looking at it again, almost as though they were browsing the group as well as the market, *"I'd have it open for five or ten minutes, move somewhere else, close it"*. Some participants did not consider using the system until they had completed their own goals at the market or as a participant put it *"after I was done with my errands and wanted to find someone"*. Another simply put the application in the background state, allowing others to use it to monitor or find them but they themselves had no desire to use the application *"I only backgrounded it, I assume people could see me"*. A side-effect of using the system in a glancing mode was that the participants accidentally ran into one another when moving about the market, unlike the monitors or hunters. Such as in the case of two participants who were moving together *"I just finished the last thing I was doing, looked up and saw him"*, this statement was interrupted by the person about whom they were talking *"yeah we totally met coincidentally"*, followed jokingly by the first participant *"I ran into him and it was like 'crap, I've ruined it all'"*.

Finally 'hunters' relates to those participants using the prototype specifically to track and move to other people in the group, hunting them down through the prototype system, or in the extreme case of one participant, *"found each one of you individually, stalked you a bit, and then found [the researcher]"*. Hunting can be thought of as a part of monitoring but with a different purpose. When people used the application to monitor they wanted to be kept abreast of the group; when participants used the system

to hunt they were wanting to meet a specific person. *"At the time I wanted to go find people, I went and found them"*. Participants acting as a hunter used the application more deliberately than either the monitoring or glancing roles. As an activity, far fewer of the participants acted as hunters than as either monitors or glancers, with only two participants mentioning specifically tracking and moving to another person. All participants did at some stage use the application to meet up with the group even when otherwise using the system as a glancer *"to find my way back here"*.

There is also some discussion of the prototype that does not fall into the three sub-themes. When asked about how intrusive the application was, the responses were split. Some participants felt that the system as it currently stood was too intrusive to use and detracted from the market itself. *"I ended up focussing on the app a lot"*, *"I was fascinated by it so I just kept watching it"*, and *"I was continuously stalking everyone"* all were comments on how it was overshadowing the market experience. One participant even said they only used it because they were *"using it more out of curiosity because I don't really like markets"*. Others however had no issue with the system overshadowing their market experience and didn't feel that it impinged upon their experience. One participant directly stated, *"it certainly wasn't intrusive"*. In both situations this feeling of the prototype intruding or not intruding on the market experience may be down to the novelty effect. The mere act of playing with a new toy might be what drew people's attention or they intentionally making sure it did not.

Somewhat related to this is the intrusiveness of the system when people were using it. Participants talked about how they constantly were viewing the system and how this was abnormal to their normal phone activity, declaring *"I generally don't have my phone in my hand at all times"*. Again however, this was countered by participants saying that they did not use

the system constantly, *"I might have a look every now and again to see where [partner] is"* or that they felt that over time they would be less drawn to it, *"I was focussing on it today but I wouldn't normally"*.

As this work is not longitudinal it would require future studies to see how the system holds up over time and whether or not it ends up being seen as intrusive or not to the experience. It is believed, however, that the more people use the system the less intrusive it will become as it is slowly adopted and ultimately appropriated by people for their own goals. The researcher predicts that in the future a similar system would be used infrequently and only when explicitly searching, making most users glancers and occasionally hunters.

5.7.3 Design

This theme related to comments and discussion about the design of the application itself. While it was not the goal of the research to create a fully realised and useable product, it is understandable that for the prototype to be of any use, even during an exploratory study such as this, it does need to be an artefact that people can use. The comments about the design fell into two main categories: positive design and negative design. Where possible the discussion around the application's design was taken into account for the next iteration of the prototype system. Therefore some of the discussion is no longer valid with regard to the final realisation of the system.

Negative comments

The most negative comment made about the system was that the prototype did not work for one participant. That is to say that they were unable to get any information about the other people in their group and that other people in the group were unable to get any information about them. This

flaw in the system was later tracked to a bug in the prototype that occurs when people refuse the system access to the location hardware of the device. The prototype did not correctly handle this situation and continued as though it had access. Interestingly enough, the bug resulted in the participant using an already identified work-around used commonly at the markets: they called the other people in their group.

There were also comments about the user interface of the application. In particular there were comments about the image being used as the arrow. As shown in Figure 5.1 the arrow image is quite broad. Some of the participants felt that this image choice was a bit vague, *"having a big arrow gives you an impression of somewhere, need something more precise"*. From the participants' feedback in the early evaluations, in later versions of the prototype the arrow would grow or shrink based upon the distance between the participants. This expanding arrow design also received comments. Some participants felt that this being used as an indication of size was insufficient to distinguishing easily how near or close away another person was. One group, when asked whether they had any indication of how far away the people in the group was, answered a resounding no, and they went into detail about the issue *"I would like to have some kind of indication of distance better than what was there"* and specifically about the size changing arrow *"that's not clear at all"*.

Going hand-in-hand with issues about the UI were issues about the prototype application itself. In particular there were complaints about the accuracy and precision of the system, *"The calibration, it's not accurate enough, you need to be able to recalibrate it"* and *"the size was good but the direction was way off"*. As the prototype is a location-based application, obviously issues relating to the accuracy carry significant weight. However when taken into consideration with other comments about the design of the sys-

tem, and other discussion going on during the interview, it was decided that the accuracy and precision of the system was sufficient for most of the participants most of the time.

The final negative feedback on the prototype related to its name. The system was called "Prototype" and had no App Icon for simplicity reasons. This meant that when participants closed the application they were unable to find it easily to reopen it.

Positive comments

The positive comments about the design were less specific than the negative. The positive comments generally discussed how the system was effective and accurate: *"it worked really well"*, *"I was going to text and ask where he was but this was quicker"*, *"it worked very well, very very well, and for any age group"*, *"the arrow tells you exactly where you have to go, you have to keep it simple and you can't get any more simple than that"*, and *"I only operated it for about two minutes before I found them it was that easy to pick up"*. There were even comments about how the prototype as it currently stood was perfectly fine and should be released without changes: *"if you gave that to us now and said 'off you go' we'd get by with it"*. In contrast with the negative discussion around the location sizing, some people saw the expanding and shrinking arrow as an effective tool to determine distance, although they were mostly using it as a way of knowing if they were getting very close to their fellow participants, *"you can tell oh he is coming towards us"*.

5.7.4 Suggestions

The codes relating to this theme are based upon suggestions the participants made about what would help improve the prototype system. The discussion around these codes has obvious overlap with the Design and

Future use themes (Sections 5.5 and 5.7.6). The Design theme, however, was about the system as it stood when discussing it and Future use is about the system as it would exist in the future, whereas this theme relates to how participants envisaged the system being improved. Some of these suggestions were used to form the next iteration of the prototype, others were not. The unimplemented suggestions were due to development constraints or to avoid changing the focus of the research during this phase of the work. No suggestions made were dismissed outright.

The first major and implemented suggestion was based around a desire to be able to see approximately how far away the person they were observing was from themselves, with one participant stating *"while I felt confident I was heading towards [group member] I didn't feel confident I would see him soon. I would like a range indicator"*, or from another group *"it should get bigger or small as you get closer"*. This suggestion was implemented as a growing and shrinking arrow in the second iteration of the prototype (Section 5.6). Once it was implemented, however, some people did still desired more information such as the distance between themselves and their quarry: *"show an estimate of distance, somewhere between near and far"*.

The second major suggestion implemented was a desire to see all or multiple people on the screen at once without having to switch back and forth to set the current person being observed: *"showing multiple people at once would be really handy, if you could turn people on or off or make a list."* Interestingly enough, once this was implemented in the third iteration of the prototype, the participants described the ability to see everyone at once as mild use or not useful at all: *"I was not looking at the arrows, just using it to turn people on or off"*. In a similar vein to being able to see more people at once, there were comments around being able to see people represented as multiple arrows all at once instead of toggling who the active person is:

"I would like multiple arrows showing up on the main screen" and to be able to know when two or more people are travelling together: *"someway of saying [group member] and [group member] are very close to each other and over there"*. There is definitely a strong desire to see more detailed information regardless of whether or not the prototype as it ended up fulfilled this desire.

The final group of suggestions were clustered around the idea of additional and supporting information. One participant wanted the ability to see where people were on a map-like interface as well as seeing heading through the arrow: *"I wouldn't first look at a map but I would like to go 'it says there, really?'"*. Other participants wanted to the prototype to send them a push notification when they were getting close to someone: *"maybe it could send me a push or something when I am within 10 metres"* or when someone started following them. Related to knowing who was currently observing you, one participant wanted to know what the other people could "see" through their prototype: *"what if I could see what they saw"*. Another suggestion was to be able to define a region and have the prototype alert you when people entered or exited the region.

A particularly interesting suggestion made by one participant was to move the system off of their phone and onto their smartwatch as a wearable application, see Figure 5.4 for a mock-up of what this might look like. This was not implemented for a variety of reasons, primarily technical. Smart watches lack the sensors of a phone, making it significantly harder to show with any accuracy in which direction other people are, which would then require a much slower wizard-of-oz approach (Molin 2004) to building the prototype. Secondly, very few people have smart watches (and the researcher did not have easy access to smart watches to test), therefore severely restricting the number of people available to perform any evaluations. Nonetheless, the idea of wearables is an interesting suggestion and

an open area for future research , as it currently stands, however, this is beyond the scope of this work.

Figure 5.4: An example of the system on an Apple Watch

5.7.5 Privacy

Privacy and control over potentially harmful data is a large problem in the computing field. There is a tug-of-war between collecting and sharing information and ensuring the information being shared is under the control of the users. This research is not looking at making privacy a core area of the work unless the participants pushed it in that direction during the evaluation. Based on the previous work mentioned in Chapter 2, it was assumed that some privacy concerns would be raised but would not be seen

as major issue.

Of the five group interviews conducted, only one group raised a privacy concern with the prototype system: *"you almost need an 'accept' to let people follow"*. Previous research would indicate that privacy is a major concern in ubiquitous computing and location-aware systems, however this was not the case in this work. The reasons for this at this point are not fully understood. It is possible that the other participants assumed that due to the experimental nature of the system that privacy was not the focus at that point in time and assumed it would be dealt with properly later. Perhaps the participants were too caught up in the moment of using the system to consider privacy. Perhaps participants trusted the researcher fully, or trusted that sharing location only with a group of known people would be seen as without risk. It may, however, be that people's attitudes toward privacy have changed. Research has shown that people are willing to forego privacy for convenience (Milne and Gordon 1993, Huang 2012). Perhaps we are now living in a world where for most people your current location *is not* seen as worth keeping private, at least not amongst friends and family.

5.7.6 Future uses

The final theme relates to the codes identified when the participants were discussing how they would use the prototype—or a similar system—in the future. This theme does not cover improvements to the prototype (that is discussed in Section 5.7.4) but the two themes obviously do interlink with one another. The most interesting part about this theme is in many ways the existence of the theme itself: people were already seeing themselves using this or a similar system in the future.

The first future use code related to places that the participants thought

that they would use such a system. Arenas, festivals, and Disneyland all being mentioned by the participants: *"there are places where it just wouldn't work but it would be great there [Disneyland]"*. The participants also talked about less specific places, with one participant describing how they would like it at places with *"ridiculously large amounts of people with few landmarks"* and *"where you don't have direct paths"* to another. Participants also discussed where the system would be of limited or no use, in particular a city block environment: *"I wouldn't think it would make sense in a city block style thing, I would use Find My Friends and a map"*.

The other codes around future use of the system revolved around ways in which the system would be useful. The first code involved using the system to monitor people you were with, for keeping an eye on children or friends, or for being helpful in professionally organised tour groups. The tour group aspect is particularly interesting as participants discussed it being useful both for the tourists in the group *"you've got the guide up front with a flag and they go 100 miles an hour and we're behind and sometimes you find it hard to find where they are"* and to help the tour guide keep track of their group *"the tour guide could see who was sorta where"* and *"when we were in Italy we lost a person and the tour guide would have been really appreciative of it"*, in both situations without needing any of the currently necessary additional visual aids. Finally, participants mentioned how in the future such a system would replace the need to call people, with one group who normally heavily use their phones saying *"we'd phone each other four or five times, or if they kids came with us we'd also call them"* and answering 'yes' to being asked whether they would use such a system to replace this need.

5.8 Summary

At the start of this chapter, this phase of the work had two goals:

- To introduce a technological artefact in an attempt to improve the communal public space for its participants.
- To gain additional insight into the role of mobile technology in communal public spaces through the evaluation of the aforementioned artefact.

This chapter began with an additional stage to confirm an observation that people's use of their devices at communal public spaces was more significant than first believed by the researcher or even the participants. After concluding this additional stage, the researcher was confident of the importance of mobile devices in communal public spaces. This made the mobile device one of three main pillars of the market, along with people attending and the space itself, allowing the research to continue toward implementing a mobile prototype system.

This work then used an iteratively developed mobile prototype to help ease the issues people at markets were having around keeping in contact with others. The reasoning behind focussing on this concept over the others identified was discussed in Sections 5.3 and 5.4. Section 5.5 discussed the experimental design and approach of this phase and Section 5.6 explained how the prototype system was designed and implemented based on the literature, the personas presented in Section 4.4, and the feedback of the participants in this stage of the work.

The findings from the prototype evaluation were discussed in Section 5.7 and showed that the system had potential and was for the most part well-received by the participants with comments about the system covering

Normal market activity, Prototype Use, Design, Suggestions, Future uses, and Privacy. Of particular note is the participants' lack of concern for privacy (somewhat in contradiction with the literature) and the overall positive response to the system.

This chapter has shown that mobile technology can be used to help alleviate issues around keeping in contact with people in communal public spaces and that mobile technology is extremely important to people at those same communal public spaces. The next chapter will discuss the overall implications of this work. This will involve creating a new means of approaching and understanding communal public spaces from a mobile technological perspective.

6

Discussion

In this chapter the findings and observations from the two applied phases of this research and the context of the existing body of literature are discussed and the implications of the work as a whole are presented. A framework for structuring and understanding communal public spaces, and technology's role within, is presented and its uses are discussed.

6.1 Introduction

From the outset this work was concerned with communal public spaces–public spaces that encourage and support social interaction with little or no restrictions put upon them–and the understanding (or lack thereof) around the role that technology plays in these places. This work is predicated on the premise that *there is an insufficient understanding into how technology can support communal public spaces*. After a review of the existing literature around communal public spaces (see Chapter 2) confirmed this gap, to further explore and ultimately address this lacking, two main phases of research were conducted: an exploratory phase (Chapter 4) and an experimental phase (Chapter 5).

Outdoor markets were chosen as the case studies for this work for a variety of reasons. First of all they are open to anyone who wishes to attend them, fulfilling one of the criteria of a communal public space. They are very communal: outdoor markets have hundreds of people enter and exit them every hour they operate. As social creatures, people in a space together will almost always end up communicating. At first glance markets share a lot of commonality with other already researched areas, such as museums, making them prime research spaces. A review of prior studies, however, show they are mostly ignored as a potential research space in the computing fields. Finally the researcher had access to several markets and very easy access to one of the markets.

This work used the People-Place-Information (PPI) trichotomy from information grounds research as the starting point to guide the exploratory phase of the work. The exploratory phase began with a survey of the Salamanca Markets, with 30 participants from the market taking part, and was followed up with an interview which included an additional 17 participants. The exploratory phase resulted in uncovering a number of purposes for which people were using their devices: information seeking, keeping and establishing contact, and photographing and sharing. Of these different activities, three of them were seen as frustrating, with the only exception being photographing and sharing.

The exploratory phase also showed a trend towards people's mobile devices being of extreme importance to them (even if they did not necessarily know this). This was explored with an additional exploratory step before beginning the experimental phase, confirming that the three major aspects of a communal public space are the space itself, the people attending the place, and the devices they use while there (see Section 5.2.3 for details). From the findings of the exploratory phase a prototype form of

the framework was used in conjunction with four personas based on the participants from the exploratory phase—a reluctant husband, a busy stall-holder, an excitable tourist, and market regular—to inform the design of the experimental phase. Continuing on from this, the experimental phase used an iteratively designed mobile application that allowed people to see at a glance where the other people in their group were located without requiring the use of phone calls or instant messaging, an understanding of the markets, or a map. The prototype had three major iterations based on the feedback of the 18 participants who took part in this phase of the work.

With the results of both phases in conjunction with the body of literature there is now sufficient information to create a framework to aid future researchers in their understanding of communal public spaces.

6.1.1 Chapter Structure

The remainder of this chapter is structured as follows:

- Section 6.2 discusses the failings of past research to create a holistic understanding of communal public spaces.
- Section 6.3 discusses the prevalence and importance of mobile technology in communal public spaces, based on the research performed in Chapters 4 and 5.
- Section 6.4 presents and discusses the framework which evolved out of this work.
- Section 6.5 concludes the chapter and presents the next stage of this thesis.

6.2 What makes a communal public space?

Communal public spaces are complex There are numerous elements that come into play to create them with the interplay between the elements being equally complex. There have been many attempts in the past to provide an understanding around communal public spaces. Each has its own strengths and weaknesses and its own focal points and research fields as discussed in Chapter 2. As mentioned earlier, this research began with the assumption that there is an insufficient understanding into how technology, especially mobile technology, is being used in communal public spaces. As such this work requires any previous framework or theory to understanding communal public spaces to be capable of handling the potentially messy interactions that can arise from people's use of mobile technology.

6.2.1 Difference of opinion

As discussed further in Chapter 2, there are numerous ways at looking at public space from a wide variety of research fields but the role that technology plays is muddled and far less clear than the parts that people and the space itself play. The majority of the work investigating public spaces from what this work called the passive fields came about in the mid to late 20th century, decades ago, and the majority of the Human-Computer-Interaction work investigating mobile technology was performed in the 1990s and 2000s (Kjeldskov 2013). In both these cases the research was performed before the onslaught of smart phones. The understanding is out of date.

Information grounds were the starting point for this research and the information grounds literature had little focus on technology. In some re-

spects technology was just a side-note, or in the case of some information grounds like the New York Public Library it was the machine which provided additional information to the information ground. In all situations, however, the technology and how people used it were secondary to the core of the information, the space, and the people. Urban design and the Third Place were no better. Urban design was focussed on the space and how people interact both with and in it, whereas the Third Place was concerned with how the information encourages the place to exist and the societal impact of such places. Neither offered significant insight into technology and its role in such public spaces.

The myriad fields underneath the banner of human computing interaction also fared no better but for different reasons. Despite there being a great deal of appreciation around mobile technology, there was far less of a focus on exploring and improving technology in communal public spaces. Some work had been done on seeing how space and technology work, from P3 systems tying people together through a space, to urban informatics using technology to encourage the growth of communicative ecologies. They all however have a predilection towards using technology to forge a new world, not to understand and enhance the existing. Technology is essentially added into a communal public space for its own goals.

6.2.2 More than it seems

At first glance this may seem to be nitpicking, that there is in fact plenty of research into how people use technology and plenty of research into public space. In one respect this is true: there is a great deal of research both into how people use technology and into how people act in public space. This does not mean that the two disparate areas can just be combined.

For the first time in human history we have access to a ubiquitous com-

puting technology in the form mobile devices. In industrialised nations there are now more smartphones than any other computing device (Kleiner Perkins Caufield & Byers 2015) and even developing nations now have a rapid mobile uptake (Pew Research 2014). This does not necessarily mean that people's use of and attitudes toward devices is also going to change. This work has, however, shown that that is not the case and that people's use of and approach to mobile technology has changed. This work has shown that people consider their mobile devices of upmost importance to their daily existence, *"prefer to use phone since its glued to our hands anyway"*, *"feel lost without it"*, *"we're all tethered to them in a way"*, even if they do not necessarily realise this until they are asked.

In addition to this, this work has identified areas in which people in public spaces are having issues, areas which the research fields have ignored, especially in the area of establishing and keeping in contact with people. Finally this work has created a new means of solving this problem with a non-spatial approach to giving insight into another person's current position and activities. People are more connected to their devices than they ever have been before, willing to have more technology in their lives and willing to have it connect them to a space and other people than ever before. Despite all this we have no frameworks to aid our understanding of how people, their devices, and a space interact.

6.3 Toward a Framework for Communal Public Spaces

This work began by taking the People-Place-Information trichotomy from information grounds research to help guide the work. As the work progressed, however, it became clear that the PPI, despite one of the goals

behind the creation of the framework being *"organizing information ground attributes for the purpose of informing system design"* (Fisher et al. 2006, p.1), was not ideal for this purpose. The PPI sees the three pillars of a place as People, Information, and Space (which are unsurprising based on the name of the framework) which places technology as a secondary component.

The PPI was chosen over the other potential framework, the Socio-Physically Informed Development Process because the PIA component of the Socio-Physically Informed Development Process had a large emphasis on the structural component of the space and its impact on the place. Based on previous work, such as the ReGroup prototype (Nugent and Lueg 2010), it was assumed that the outdoor market layout would not greatly impact the research and as such the focus on the spatial aspects would be wasted. While this does appear to be the case in this work, the PPI itself did end up being insufficient. Whether this would also be the case for the Socio-Physically Informed Development Process it is impossible to say and is a good area for future work to explore.

If the goal of a project is to create a technological artefact for a place, the PPI provides a high level view of the different properties of the place by providing a list of *what* effects the place. What is missing is the how and why. Without the how and the why, any system developed would very likely make the same mistakes that any existing solution has or lead to a system that people do not wish to adopt. Taken in combination with the level of importance people placed on their mobile devices, this work takes the approach that any framework that aims to provide an understanding of a communal public space must incorporate mobile technology. As such, in Phase Two it was decided to use three different pillars–the people participating, the space they are inhabiting, and the devices they have and use–at the forefront when it came time to design the technological intervention.

Four different personas were created based on the market participants and these personas were then used as the design inspiration to try and introduce a change to the system. This work focussed on the issue of maintaining and establishing contact with people. The technological intervention was an iteratively developed prototype smartphone application that would show the participants a heading of where the other people in their group are. The design was based initially on the first phase participants' comments and subsequently on prior research into location and social awareness application. An important aspect of the design was to try to avoid tying the system to the space of the market as this was an approach which had been already heavily explored.

Groups of people were then given the prototype and asked to use it during their market activities. Afterward the participants took part in a group interview about how the system worked, what they used it for, and any additional information about the system they wished to give. From this it was learned that people were using the system to monitor the group, for occasionally glancing at where people are but otherwise ignoring the system, and for hunting specific group members. Every participant said they saw the potential in it and would use a similar system in the future, including those who only used it sparingly or simply placed the prototype in the background of the device and allowed the application to continue running so others could find them but without it being active on the device otherwise.

This research took the approach that devices are an under-explored aspect of public spaces and systems being created to support public spaces are generally doomed to fail because of this lack of understanding around the part mobile devices have to play. Making devices a critical component of this research, however, led to the creation of a prototype system

that was well-received and solved a problem that previous systems had failed to solve. Continuing on from this point, the next section will look at a framework for system design and place insight for communal public spaces based on this work.

6.4 People, Space, Device

Throughout this work there has been a heavy focus on mobile technology and how people use it while at the market. This is not surprising, with the research focus being based around the concept of technology in communal public spaces, however, the way in which people are using their technology at these places has never been a focus before. The importance that each participant gave to their device and the role that it plays at the market makes it stand out from being simply an extension of themselves and more as player in the place itself, every bit as important as the people and space to the overall picture.

This work proposes the People Space Device (PSD) framework as a means of understanding communal public spaces. Inspired by the People Place Information trichotomy (PPI), this breakdown moves information out as one of the scaffolds of a communal public space and sets the device in its place. Information instead flows between the three different pieces of scaffolding. Scaffolds in this sense relate to providing a structure around thoughts and information to help guide any decisions made, not to a rigid step-by-step process. By describing a communal public space through this scaffolding, a researcher will be better equipped to explore the flow of information and the goals behind why a person is doing something at a space. The intention of People Space Device is similar to the PPI in that it provides a high-to-medium level look at a place and provides a

structure to guide further exploration, especially with the intention of aiding future systems development. As such, PSD does not break down the three scaffolds into the same distinctions as the PPI itself and obviously has a different focus with some components having a heavier emphasis and others a lesser than in the PPI trichotomy.

The PSD is broken up into three scaffolds: People, Space, and Device. The different properties of the place are categorised and placed each underneath their respective scaffold, shown in Figure 6.1. The PPI trichotomy, on the other hand, is broken into three distinct categories–People, Place (what this work calls Space), and Information–with the different properties of the information ground being categorised and placed underneath each category, shown in Figure 6.2.

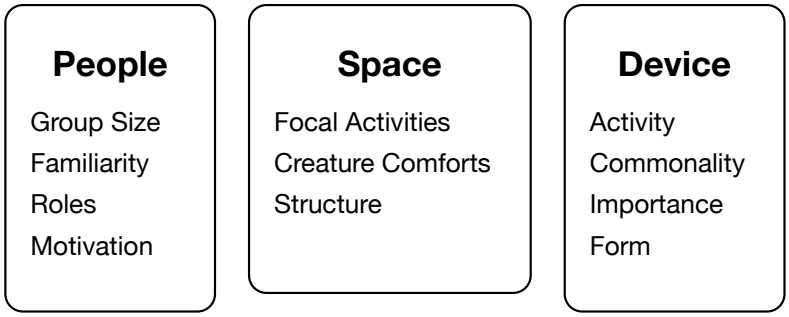


Figure 6.1: The People Space Device Framework

It is worth emphasising that the PSD framework is not intended to be a step-by-step process resulting in idealised systems for a place. A researcher cannot throw collected data about a place into the PSD and receive perfectly designed concepts at the end. Like many qualitative frameworks–such as P3 systems or the Socio-Physically Informed Development Process (see Section 2.8.6 for a discussion of these) or the PPI that inspired it–the PSD is designed to provide scaffolding and structure to a person's thoughts

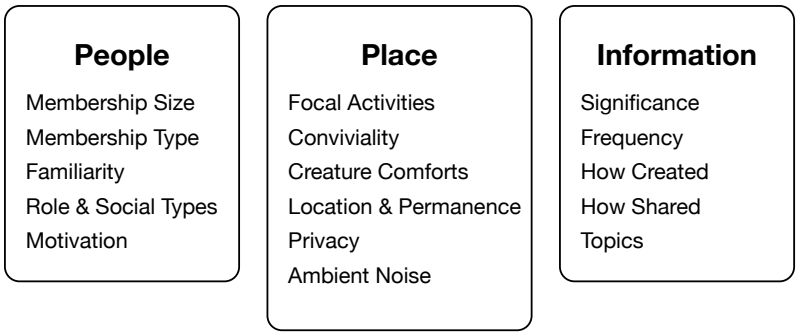


Figure 6.2: The PPI Trichotomy

and collected data, aiding in design and understanding and not performing it.

The remainder of this section is structured as follows:

- Sections 6.4.1 to 6.4.3 discusses the three different scaffolds that make up the PSD, People, Space, and Device.
- Section 6.4.4 looks at how the PSD framework is intended to be used.
- Section 6.4.5 discusses the impact which the Chapter 5 prototype and the PSD have upon each other.
- Finally, Section 6.4.6 discusses the differences between and the strengths and weaknesses of the both the PSD and PPI frameworks.

6.4.1 People

The first scaffold in PSD is the same as it in the PPI, people. Much like the PPI the scaffold has Motivation, Familiarity, and Roles. Membership type and Size are discarded in PSD and instead Group Size is added in their place. The reason for this change is that communal public spaces have a

larger large population and more frequent encounters than the smaller and more focussed populace of previously identified information grounds.

In the PPI trichotomy, membership size relates to the size of the information ground itself. That is, how many people are participating in the information ground. In the case of an information ground this property is worth knowing. Information grounds identified and studied so far are all quite small in size and encapsulated the entire place (Fisher et al. 2006).

The size of the information ground has been shown to have direct impact upon the way information is created and shared, with smaller information grounds having a higher level of intimate knowledge sharing than the larger ones (Fisher et al. 2006). At a communal public space, and especially in the markets used in this research, the total number of people involved is *significantly* larger than any previously identified information ground. Fisher et al. (2006) described a large information ground as any with over 50 members with most information grounds between 2 and 25 people, whereas each of the markets in this work have thousands of people walking through them each day they operate. Due to these size differences, there is a much lower opportunity for people to be able to talk to everyone else participating in the space or to engage in long conversation; the intimacy will be lower.

This has ramifications on the information being created and shared. The PPI predicts that a large information ground will have information sharing of a lesser significance than a small one, and as discussed in Chapter 4 this was found to be the case. As such, with the change in focus of the PSD away from information as a preeminent component of the framework, membership size is less important. The size of the group of people that attend the communal public space is, however, of more interest.

As revealed in the findings of Chapter 4, people attend the market or are

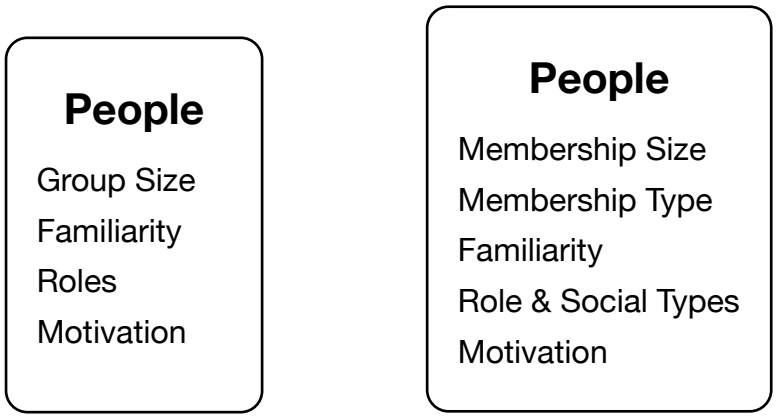
meeting up with others after arrival with whom they consider themselves to be highly familiar. This creates groups with the size and intimacy of small information grounds, as people will be engaging primarily with their group and then the general population of the communal public space. This has ramifications for system design as a system designed to support a small intimate group will be different from one to support hundreds or even thousands of people.

In a similar vein to removing Membership Size, Membership Type is also removed due to its lack of relevance to the place. Membership Type refers to the nature of the information ground, essentially is it open to the public or closed to only members (Fisher et al. 2006). A communal public space is by its nature public, open to everyone. The restrictions put upon them are very minor and there is no real concept of an (oxymoronic) private public space. There will still be differences between the people inhabiting a communal public space, such as stallholders compared to attendees, but this is encapsulated in the Role property of the PSD.

It is for both of these reasons that the PSD framework has Group Size as a property of the People scaffold. In their place, Group size offers a researcher an insight into how big or small the groups of people participating in the communal public space are, in effect breaking the place into groups of people participating instead of thousands of individuals.

Motivation

Motivation in PSD relates to the reason why someone is attending a communal public space. This could be for any number of reasons and also includes the possibility that people are attending unwillingly, what Fisher et al. called a hostage of the space (see Section 2.4.3 for more details) and there were market attendees who were only there because they attending



(a) PSD (b) PPI

Figure 6.3: People properties of the PSD compared to the PPI

with others.

Taking the Salamanca Markets as an example, the most common motivation that non-stallholders had for attending the market was to experience the market itself; the tourist attraction nature of the market was their motivation. *"Last time I was here [Hobart] I wasn't able to go so this time I made sure I could go. The market had a reputation"*, *"Just to get out, it is my day off"*, *"On holiday and the girlfriend wanted to come"*, and *"Bored, just to browse, maybe something will catch my eye"*. After the market itself the two most common motivations for attending were for the availability of fresh foodstuffs and because they went to the market with others.

In the case of the prototype system from this research, the motivation did not directly filter into design as in the system was not meant to improve a person's motivation. Rather, the prototype was designed around ensuring that the system did not interfere with the main motivation of many of the market participants. See Section 5.7 for more details on the impact the prototype had on the market experience.

Familiarity

The PSD uses familiarity to present how familiar, or how unfamiliar, a person is with the people with whom they interact in the space. Each person a researcher encounters will have differing levels of familiarity with the people with whom they interact. This property, when taken overall, will provide a breakdown of the familiarity levels on both an individual and a place-wide basis. This allows the researcher or designer who wishes to introduce an artefact to ensure it is appropriate for the group of people they wish to investigate, whether that is a large group of unfamiliar people (such as the entire market) or a smaller close-knit group of friends and family. The PPI also has a familiarity property but it is an aggregate property, showing the overall familiarity between people participating in the information ground. As discussed above, despite their similarities the PSD and PPI are not the same. The PSD takes a much more fine grained approach to a place than the PPI, and knowing how familiar people are with the general places populace will be of less use than knowing how familiar they are with the people with whom they are participating in the space.

Using Salamanca Markets again as the example, people attending the markets generally attended with family members or friends and as such the familiarity is very high. Some people, however, attended as part of larger groups, or attended alone, or in the case of stallholders attend alone every week. These people have a much lower level of familiarity with the people with whom they are involved at the market. In the case of the prototype system from this research, the application was specifically targeted at the smaller groups of people with very high familiarity amongst the members of the group.

Role

The role property in PSD is the *part* a person will play in the place and could take a variety of different forms. A person's role could be as simple as a visitor, or could take more complex forms such as child minder, saleswoman, unwilling attendee, or even all of these at once. The PPI also has a Role property (although it is broken up into roles and social types); functionally, however, the PSD and PPI Roles properties are the same.

Roles are a more complicated property than they may first seem. See Section 2.4.3 for the literature discussion on roles. At first glance the market has two different roles—stallholder and market attendee—but again using Salamanca Markets as an example the complexity of roles is readily observable. The roles people had varied a lot depending on what their motivations were and with whom they were attending the market. For example a person attending the market alone while awaiting some friends might seem to have the simple role of market attendee, but if they often attend the market and heavily interact with the stallholders then they might also have the role of market regular, or if they attended unwillingly because others went then they might have the role of reluctant attendee. As such, roles are a complicated aspect to capture and understand. Any work using this framework should keep this in mind.

The prototype from this research took a hands-off approach to handling roles. As the roles are very complex it was decided not to attempt to codify roles into the application. The design of the system was flexible so that people of any market role should be able to make use of the system. While it is not possible to determine if it is the case, based on evaluation of the prototype system the author believes the roles (or at least the unwilling participant roles) may have been revealed as the Glancers and Hunters (see Section 5.7.2 for details). Again, it is worth stating that this is just a

hunch and is not confirmed, but is an interesting avenue for future work to consider.

Group size

Groups size is a description of the sizes of groups who attend the the space. As such this will be similar to the familiarity property. It will not be a single metric but a range of possibilities that the space possesses, from individuals roaming around alone to large tour groups exploring together.

When talking to people at the markets, the size of the market was not raised as a positive or negative factor. People cared more about what was available at the market and with whom they were going and not the number of people at the market. In some respects this behaviour is going to be self-fulfilling; obviously people who do see the size of the market as a negative will be unlikely to be there to participate in this study. As such this is a gap in the framework as there is insufficient information to know what impact the total population of a communal public space has on the people that are a part of it.

Group size is a departure for PSD from the PPI trichotomy. In the PPI, membership size (the closest attribute) is a headcount of everyone who is involved in a particular space, giving a metric of the number of the people in the place but little else. Group size, in combination with the familiarity change, accounts for the membership type attribute from the PPI, as communal public spaces by their very nature of being *public spaces* are open membership so there is no need to account for this.

Of the 74 non-stallholder participants in the two phases of this work only four mentioned talking to other people (including stallholders) who were not part of their group. This number is likely lower than reality, with the participants simply forgetting discussions they had. The comments on

these interactions ranged from positive comments about the other market attendees, *"I don't like to talk to people much but it's sometimes nice to sit down and have a cuppa with others"* to the negative *"they're busy or surly looking so it's hard to ask questions"*. Some participants saw the other people at the markets as new information sources, *"I tried to find pie shops in the market with my phone but couldn't find anything, so I ended up asking a local who I met wandering the market and he told me where to get pies"*. Although it is interaction, it is a very low level of interaction with the people being little more than a new interface to knowledge that would not have been necessary had the technology worked as the participant had hoped.

When talking about their pre-existing social groups the comments were quite different. One participant did not talk to anyone at the market but would send her friends pictures of things she had found. Another participant had a similar approach, sending photos to friends and family elsewhere, having done this *"three or four times already today"*. There was also a great deal of instant messaging and calling going on with participants using their mobile devices to learn when their friends where coming to the market *"as they all live up in Battery Point and come down to the market most weeks but don't always remember to tell me when they're there"*, or to link up with people from whom they had separated earlier: *"Keeping in contact with my husband, he isn't a great market person, linking up for lunch"*, *"get in touch with someone I've lost. I'm with some people, they stopped but I kept walking"*, and *"just to call each other to see where we are"*. Only two participants did not use their mobile devices to communicate with their social groups and both of these participants came to the market alone. Based on discussions with market participants during this research, this work postulates that while at the communal public space the size of the group of people at the space together will have more of an impact than the sheer size or lack thereof of

people.

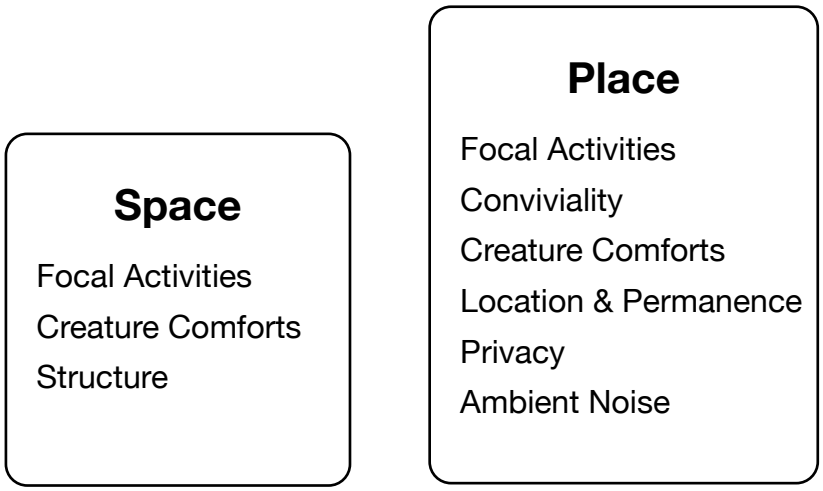
The first iteration of the prototype simply had a scrolling list of people that the participants could use to determine upon whom they wanted to focus. Based on participant feedback for the third iteration this was changed to show all the group on the same screen as the arrow (as well as showing smaller heading arrows for everyone) instead of on a separate view. The decision to split the view into four was determined by looking back at the group size property and seeing that few people attended with groups larger than four people. If the prototype was to continue its evolution or to be applied to similar but different spaces, this decision would need review.

6.4.2 Space

The Space scaffold describes the part of the communal public space's own attributes, not those that are derived when people use it, which was described as space in Section 2.2. This includes physical properties such as the walls, footpaths, or chairs within the space as well as properties that only become apparent when people start inhabiting it, such as the ambience or focal points. As with the People aspects of the PSD, the Space scaffold is based upon the Place component of the PPI and borrows from it, modifying it where appropriate yet fulfilling the same function. Figure 6.4 shows a comparison of the Space scaffold of the PSD and PPI. The different components within are focal activities, structure, and comforts.

Focal activities

Focal activities in PSD provide the impetus for attending a particular space. This leads directly into providing a motivation for a person to visit the communal public space. Not all focal activities will necessarily be connected to a motivation. For some people (particularly those attending solely at the



(a) PSD (b) PPI

Figure 6.4: Space Properties of the PSD and the PPI

behest of others) their motivation is *very* separate from the focal activities of the space. An example of this would be someone participating in the market for the tourism aspects of the markets but also have food while there, their motivation is the market and their focal activities are food. Communal public spaces are by their very nature of being a public space designed to be their own focal activity, with people's motivation for attending simply being to have gone and the myriad activities within are secondary to the draw of the space itself. However this is not always the case.

In the case of the three markets in this study, the markets themselves were often the draw; people were attending so that they could experience the market. There were other focal activities as well. Some people were at the markets for specific items, often food. In the case of stallholders the focal point was their stall itself and the act of running it.

The use of the focal activities property in the prototype was minimal. As the decision was made to focus on the issue of maintaining contact

amongst a group of market attendees, there were no design features specifically focussing on the focal activities of the market. In this respect it is similar to the Role property discussed earlier in Section 6.4.1.

Structure

This property relates to the structure of the space itself, the design of the public space. This includes a variety of attributes, the largest being the layout. In the case of the Salamanca Markets, the layout of the market follows a road with stalls winding down and through the middle of the road, splitting the market into two paths. There is a park on one side of the road and permanent commercial spaces on the other. Part of the struc-

Figure 6.5: Salamanca Markets Map (Hobart City Council 2015)

ture also includes its location; even if it affects nothing else the location of a space will impact who can and cannot easily attend. Structure also includes attributes that only emerge once people start using the space, such as ambient volume and personal space. Again, taking the example of the Salamanca Markets, there is a great deal of personal space surrounding the market near the park but far less in the stall-created paths. Due to buskers presence throughout the market there is a great deal of ambient noise. How the structure of a communal public space affects the people using it needs consideration. If the communal public space is large and open, this will change what activities people want, or need, to perform and how they go

about them.

Unlike many of the other attributes in the PSD, structure is an amalgamation of several properties from the PPI: ambient noise, privacy, and location and permanence. These different properties were combined due to the participants rarely mentioning any aspects of the market as affecting their use of it. In particular, privacy was only mentioned once and only in a different context than the market itself. It is possible that privacy is not a concern for people attending a communal public space due to its *public* nature.

The public nature of public spaces also means that any system created for them needs to be flexible. While people may implicitly understand that because they are in public they may be seen or overheard it does not necessarily mean that they will agree to everything. For example, stallholders may not want their items photographed—especially those selling art—or parents might not want their children photographed, or buskers may not want their performance recorded. The public nature of the market means that privacy was not a concern for this work but it may be something future researchers may need to consider. The research and any systems developed from it must be flexible lest it be rejected by its participants for privacy concerns.

The Structure of the communal public space is still going to have an impact on the people participating in it as well as on how and why they use their devices at the market. As such Structure should still be included in the framework. The permanence aspect from PPI is not fully explored in this aspect of space. All of the markets explored have very particular rules around their permanence and none of the market's rules were the same. The PPI trichotomy was concerned with capturing information ground characteristics. The permanence of a space is a large component behind

the lifecycle of an information ground (Fisher et al. 2006), but a communal public space, or at least those explored in this work, has a much more casual level of engagement between the people than previously identified information grounds. As such, the permanence aspect is possibly not as important to a communal public space as it is to an information ground, but this is not fully understood either way.

The structure property had a large impact on the design of the artefact prototype for this research. As the structure of the Salamanca Markets is flat and linear (see Figure 6.5), as well as very loud and busy, a traditional spatial approach to navigating and moving about based on maps or landmarks would not work. This was part of the impetus to use a simple arrow based approach, removing the spatial aspect of the system and simply making it a direction of which the participant could make use.

Comforts

The final aspect of the space, Comforts, captures the aspects of the space that make it more enjoyable, that provide an improvement to the atmosphere of the space itself. These cover a variety of aspects, from physical features of the space such as available seating or attractive scenery to the more personal aspects such as friendly people or a positive environment. Comforts can be thought of as secondary draws to attend a communal public space beyond the primary focal point. In the case of the Salamanca Markets, a common focal activity was simply to visit but some of the participants also viewed the food as a positive. In this case the focal activity was the experience and the food a Comfort.

The two matching properties in the PPI, Creature Comforts and Conviviality, were combined together for the reason that people involved in this research did not talk about the two aspects independently of one an-

other. The atmosphere-improving aspects of conviviality were spoken of in the same way as the creature comforts. This work raises the suggestion that both these aspects are quite similar to one another; they are both secondary reasons to participate in a place outside of motivation and focal activities and therefore splitting them up further does not provide any additional insight into how a space operates.

For this research, much as with the focal activities discussed above in Section 6.4.2, the impact on the design of the prototype was minimal. The only impact Comforts had on the design of the prototype was to make sure it did not impact on the atmosphere of the market and not specifically cater to some comforts or to exclude others.

6.4.3 Device

The Device is the component in the PSD that differs the most from the PPI trichotomy and is the change that makes the PSD framework genuinely distinct from the PPI trichotomy rather than a simple update and tweak for public spaces. Whereas there other two scaffolds in the PSD are moderately different from their PPI equivalents, Device is an entirely new construct that does not have an equivalent in the PPI. Device takes the place of Information in the framework. This is not to say that information has no place in communal public spaces or that there is not information being created or shared in these places, simply that from the perspective of this work the information itself is secondary to how people are creating or sharing it.

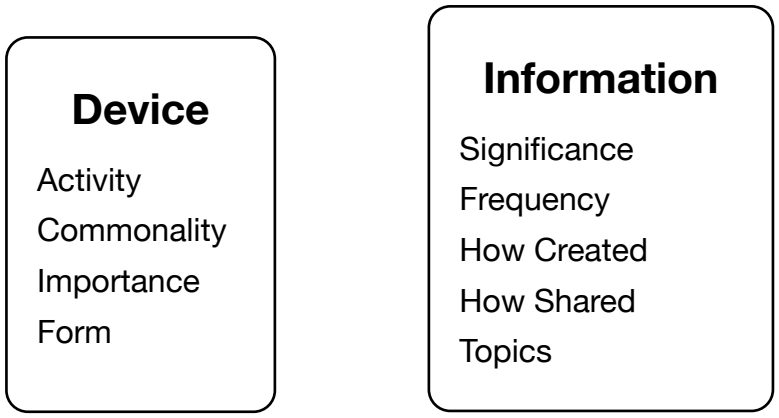
Throughout this work there has been a focus on mobile technology (indeed it is one of the major components of this work, see Section 1.2). This work is predicated on the assumption that there is a lack of understanding into what role mobile devices play in communal public spaces. As such

it is almost inevitable that this work promotes the devices to a position of importance in these spaces. The subsequent promotion of devices into this framework is not simply due to the whim of the researcher but is a reflection of the difference in the goals of the PPI and the PSD and the changing attitude of society toward mobile technology. It has been discussed before that one of the original intentions of the PPI was to capture information ground properties in order to aid in identifying new information grounds, to use this collected information to optimise current information grounds, to encourage new information grounds, and to aid in system design.

As people's attitudes about their mobile devices have changed so have (or rather so should) the tools which researchers and developers use to explore and improve. The PPI's focus on information—the topics, the significance, and the frequency—all look deeply into *what* it is that is contained within the information. Only a single property in the PPI gives us the *how*: how created and shared. In addition the part technology has in this property and the framework overall is poorly discussed. Even in the originating work on the PPI, the importance of technology was understood as playing a part, *"the role and impact of other modes such as online chat, instant messaging, cell phones, notice boards, newspapers, etc., need be considered"* (Fisher et al. 2006, p.1), but the role they had to play was not addressed at that time.

Based on the experimental components within this work (see Chapters 4 and 5), people in communal public spaces use and place a great deal of importance on their mobile devices. Devices are now an integral part of the experience in communal public spaces. Going hand-in-hand with this, people did not seem to put a great deal of emphasis on the information their phone enabled them to create and share. Information in the PPI is given a large role and this makes sense based on its original goals, but with the change in people's attitudes and habits around mobile technol-

ogy and the differences between an information ground and a communal public space, a device as the third scaffold in the framework is of more use than information. Information does not simply go away—communal public spaces are not devoid of information—but this work captures the reality that how information is created and shared is of more use to future researchers and developers than simply having knowledge about the information itself. This is the part that devices play in communal public spaces. Figure 6.6 shows a comparison of the properties of the Device scaffold from the PSD and the Information scaffold from the PPI.



(a) PSD (b) PPI

Figure 6.6: The PSD Device and PPI Information

Activity

Activity is the most obvious of the different properties within the Device scaffold. Activity is the function the device is performing for its person. As modern devices can perform a large variety of activities, this property will contain a similar variety of activities depending on the goal(s) the person currently has.

In the case of the three markets in this study, the activities covered a wide variety: from navigation to taking photos to calling friends. For an individual person represented in the PSD, the activities would not necessarily be so wide unless they themselves have performed all these different activities while at the space.

The activity property had a large impact on the prototype. The very focus and intent behind the prototype is tracked directly back to the activity of people trying to contact others through their mobile devices. This activity also directly affected design through influencing the choice of using a non-spatial approach to present location with few participants using maps or location sharing tools, preferring instead to use their phone.

Commonality and Importance

Commonality and Importance are two interlinked yet distinct parts of device activities. Commonality relates to how often and for how long people spend performing certain activities on their devices. Importance is related and gives an approximate understanding of how relevant an activity is to the person. Together these two allow an insight into what activities are being performed the most and which are the most important to a person. These two are related but not quite the same. Just because a device is being used a great deal for a certain activity it does not mean that it is as important as other activities that occur far less frequently, or in the case of a person having a device with them for contacting others, the duration may be zero but the importance will be very high.

In the case of the marketplaces some activities, such as taking photos, had a high commonality and a moderate level of importance whereas as other activities, such as texting to keep in contact with the rest of the group, had a low commonality but a very high level of importance. Navigation

had low commonality and low to moderate importance as did searching for information about the markets. As this is a property that is going to be determined by the people at the communal public space, there will be a wide variety of values here. What is important to one person may not be to another, and the feature one person uses constantly, another may never use.

Much as with the activity property, the commonality and importance had a large and direct impact on the prototype. While the commonality of some other tasks was higher, the importance of keeping in contact with the other people in the group was very high to the research participants. This was another factor behind deciding to focus the prototype on maintaining contact as opposed to other possible activities.

Form

The final property in the Device scaffolding is Form. Form relates to the nature of the device itself, that is, the actual design of the device. While collecting information about this property may seem perfunctory—after all, in this work every person encountered has either a slate style touch phone or tablet—it is important for multiple reasons. First of all, no two communal public spaces are going to be the exactly the same. That the markets used in this work contained people with similar devices does not mean that other places will follow this pattern. Secondly, computing technology changes at a blisteringly fast pace. Only a few years ago modern style smartphones did not even exist nor did modern tablet devices. A framework that is too heavily tied to the technological assumptions of its own time will very quickly be of little use. Finally, the Form property allows the researcher to capture instances when the people may be using multiple devices for different purposes, such as using their phone to keep in contact

with friends and family but taking photos with their SLR camera.

The Form property provides a researcher with a simple overview of what style of devices people are using. With this overview any future research or system developer can ensure that they will be targeting the correct style of device, regardless of whether this is or is not the majority device. The overview also allows researchers to see whether their assumptions about the devices in a communal public space (should they have any) match what people are using.

Going back to the marketplaces studied in this work, the overwhelming style of devices were, as mentioned above, slate style touch phones. There were also a few slate style touch tablets and even a few additional devices such as SLR cameras, however the overwhelming majority of people encountered as part of this work had *modern* smartphones.

For this work, the form property had a large albeit obvious impact on the design of the prototype. Due to the near ubiquity of smartphones at the market it made the decision to focus on smartphones quite easy. At the same time, the same ubiquity made it foolish to *not* focus on smartphones.

6.4.4 Using People Space Device

This section will discuss how the PSD is intended to be used. It is worth restating that the framework is intended to aid the researcher to structure their thoughts and collected data for aiding understanding. Like many qualitative frameworks, it does not provide the understanding by itself. The PSD is in this respect similar to Activity Theory in HCI research: it does not provide rigid steps but through a breakdown of human practices into easily understood components it can aid a researcher in their understanding (Kuutti 1996).

As with the PPI trichotomy the goal behind the PSD is to decompose

any information collected about a communal public space into understandable and relatable chunks. Unlike the PPI, which was an aggregate of an information ground showing the overall picture of a place, the PSD is intended to have multiple snapshots, with each snapshot representing a different person in the communal public space. To explain how to use the framework, this work will use the interviews and findings from participants from the earlier stages of this work starting with one participant from Salamanca Markets who attended the market with their husband.

People properties

The People scaffold of the framework has four properties to satisfy. The person's motivation was determined by asking her during the interview about her reasons for attending the market. Her motivation for attending was the market itself; she was a visitor that had been to Tasmania before but had missed the market last time and was determined to go this time around. The market had, as she put it, *"a reputation"*.

The participant attended the market with her husband so their familiarity is going to be very high, falling into the *"know people well"* category from the PPI trichotomy. Going hand-in-hand with their familiarity, her group size is two, herself and her husband. This group was not, however, moving through the market together, it had split apart and each person was participating in their own way.

Finally their role in the market is a somewhat more complicated property and cannot be as easily determined as the other properties. The first and obvious role the participant has is tourist; she attended the market to enjoy and experience the market itself. She did, however, attend with her husband who *"isn't a great market person"*, which required her to keep in contact with him and organise their plans remotely, also making her a

planner for the group. A breakdown of the participant's People properties are shown in Figure 6.7.

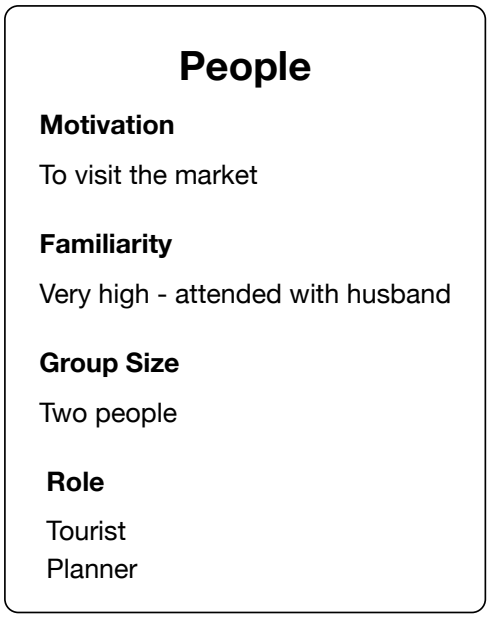


Figure 6.7: Example People Properties

Space properties

The next step is to determine the Space characteristics of the market: the focal activities, the structure, and the comforts. With this participant the focal activities were not clearly identified from the interview. She did state, however, that they were *"linking up for lunch"* with her husband so the food at the markets or the nearby restaurants was at least one focal point for the participant.

The market structure does not significantly change from person to person but each person will react in different ways to the structure of the market. The layout of the market means there is little personal space inside the majority of the market and ambient noise will be quite high, reducing the

amount of conversation that can flow between the couple. The group did split up to explore the market at members own pace.

As with the focal activities, the comforts of the market were not fully explained and could cover a variety of topics from seating and public toilets to restaurants and pubs or even a place to leave her husband. As such this property for this participant is left blank. A breakdown of the participant's Space properties are shown in Figure 6.8.

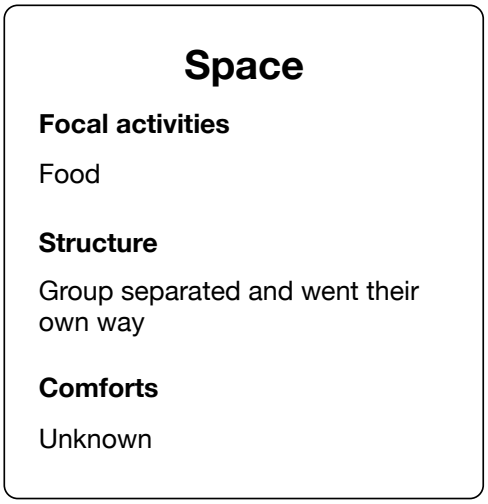


Figure 6.8: Example Space Properties

Device properties

The final step is to capture the Device properties: Activity, Commonality and Importance, and Form. The participant only used their device for a few different activities: to perform *"a bit of research on the market, time but not location, a few basic details"* and for *"keeping in contact with my husband"*. These activities were performed infrequently and while the general browsing was of low importance to the participant, keeping in contact with her

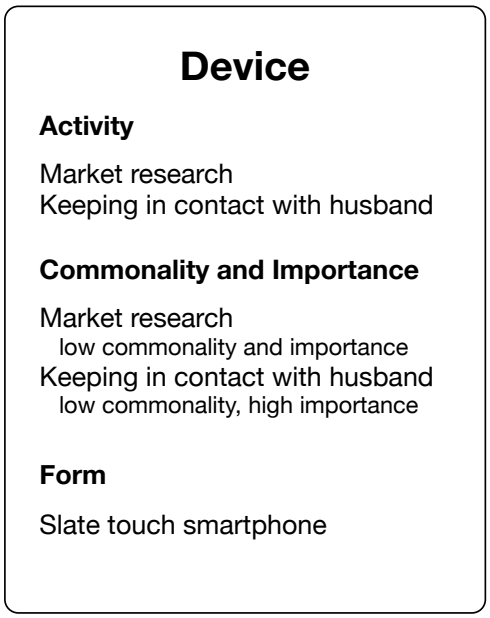


Figure 6.9: Example Device Properties

husband was of a much higher level of importance. All of these activities were performed on her mobile phone, which was a slate style touch device. A breakdown of the participant's Device properties are shown in Figure 6.9.

Putting the pieces together

Now that the three scaffoldings have their properties, they can be viewed together to offer a snapshot of the particular person and their market experience. These snapshots can then be combined with others, one for each person, to create an overall view of how the market is operating. With this overall look at a particular communal public space, the PSD provides both a high-level view of how it exists as well as the ability to dive back into any individual snapshot and get a medium-level look at their actions and motivations. This is shown in Figure 6.10, the individual snapshots can

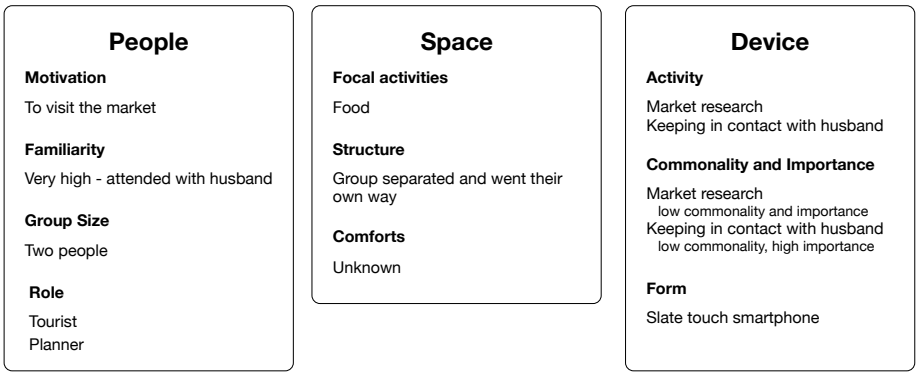


Figure 6.10: The completed PSD snapshot for this participant

then be used as a basis for future use, such as the starting point for personas, and the high-level picture can be used to see general trends in the communal public space. The snapshots and the overall picture can also be used to verify any design decisions, giving the designer a means to track any changes back to a particular property or an aggregation of properties.

While this section may have given the framework the appearance of a fully structured and rigorous process, the intent behind the PSD framework is not to provide a step-by-step process to follow to discover the perfect answer to a question. It is still very much the responsibility of those using the PSD framework to interpret any resulting picture it may reveal. The intent is to provide some structure to a researcher's thoughts about the communal public space, not to be a rigorous process. The PSD informs and guides a researcher's thinking; it does not replace it. This work takes the approach that for a researcher, keeping these scaffolds and their properties in mind while researching a communal public space is of far greater value than breaking down the place into these scaffolds without any framework to support it.

6.4.5 The PSD and the Prototype

The prototype discussed in Section 5.6 was used to both explore and to inform the design of the PSD framework. The prototype was created for two reasons. One is because it is a natural next step to take when following the methodological approach laid out in Chapter 3. The second reason is to inform and guide the framework that was emerging from the research. The design ideas for the prototype came directly from the understanding that was generated by using an evolving form of what would become the PSD in Chapter 5.

Several of the design elements of the prototype can be linked directly back to ideas emerging out of the PSD and these are described above in Section 6.4. For example, the decision to focus on the issue of establishing and maintaining contact with other people in the group came from the activities discussed by the interview participants. The decision to make the system independent on a map is traced to the lack of mention of map usage or navigation activities in the interviews. The PSD was also used to help validate the personas, as the PSD snapshots created connected well with the four personas from Chapter 4. These personas did not require any changes and they were therefore used in the design of the prototype system.

The results of the evaluation of the prototype were fed back into the evolving framework, informing on and improving it. Based on the findings from the prototype evaluation, the PSD-based-design of the system was successful at improving the experience of maintaining contact with people in a group at an outdoor market.

6.4.6 The PSD compared to the PPI

As has been discussed above, the PSD shares similarities to the PPI trichotomy but there are also several differences between the two. These differences are not due to flaws in the PPI but instead represent a change in focus between the two different frameworks. The PPI ultimately is for and about information and its flow, whereas the PSD is more concerned with people's actions and activities than the information that supports these. When taken from a perspective of attempting to understand a space and how people act within it, having a thorough understanding of the *what* is going to be of less use to a systems developer or researcher than the *how*. In many respects the PSD could be seen as modification of the PPI, one that focusses on the needs of people exploring communal public spaces attempting to modify the space.

Both the PPI and PSD have their place and which one should be used by a researcher will depend entirely upon the overall objectives of the work. If the intent to is gain an understanding of a space from the myriad people's perspectives to aid future development and change in that space, the PSD is better. If the goal is to create a high level picture of the information in which people are interested and how important it is to them within a space, the PPI is a better choice.

6.5 Summary

This chapter discussed the implications of the work conducted. The chapter began with a discussion of what makes a communal public space and why there are no existing frameworks suitable for exploring them. It then examined the importance that mobile devices play in communal public spaces. Based upon the exploratory and experimental phases of this work,

it was discovered that mobile devices now play a crucial part in the fabric of a communal public space.

Using all of the above as a basis, a new framework for providing insight and to guide system development in communal public spaces was developed based upon the People-Place-Information trichotomy from information grounds research. This new framework, the People-Space-Device framework, provides a medium-to-high-level snapshot, offering future researchers and developers multiple levels of insight into the *how* and *why* people undertake the activities they do when within communal public spaces.

The next and final stage for this work is to reflect upon the research goals and objectives as well as to summarise the contributions of this research as a whole and the future directions in which this work could be taken.

7

Conclusions and Further Work

This chapter combines and presents all of the previously reported components of the research to fully conclude the presentation of the work. The contributions are presented in light of the research objectives and scope, and the limitations of the research is discussed. The future work possibilities are then presented before ending the dissertation with some parting thoughts.

7.1 Introduction

In Chapter 1 this presentation started with the original premise of the work that *there is an insufficient understanding into how technology can support communal public spaces*, that for researchers and developers there is not enough accumulated knowledge to help guide future research in or system development for communal public spaces. After a review of the existing literature (presented in Chapter 2) confirmed this initial premise, a series of observations about the state of knowledge of communal public spaces was made, viz, that:

- There is a lack of research and understanding into how the people in communal public spaces interact with mobile technology.
- There is a lack of research into how technology can support people's activities and goals inside public space.
- Public spaces are poorly understood from a design perspective. There are no guides or frameworks specifically for understanding communal public spaces from a technological perspective, only a myriad related topics.

From these observations and guided by the overall premise, three research objectives for this work were created. These objectives are detailed below.

7.1.1 Research Objectives

The research objectives of this thesis were to:

1. Uncover what role technology plays in communal public space.
2. Understand what friction around technology use in communal public spaces.
3. See what technological artefacts can be introduced to better integrate technology into people's activities in communal public spaces.

In many ways technology has been an outsider in public space. The research either has focussed on the people and their interactions within the space or the focus has been solely on the technology, and its interaction with the people and space has been poorly understood. No solution will provide a perfect answer for everyone (or no solution so far). As such this work sought to uncover which activities are well supported and which are

not. Finally, this work is in an action-based discipline and using an action-based methodology it was envisaged that a technological artefact should be introduced to attempt to relieve some pain points identified during the work.

These three objectives were the guiding points for the entire work and shaped the research at all stages. These objectives are quite broad, and are to be interpreted within the context of the project's scope. The scope of the work is was to:

- Focus on outdoor markets as an example of communal public spaces.
- Focus on current activities being undertaken at outdoor markets.
- Focus on mobile technology.

While many places fit under the banner of communal public spaces, outdoor markets were chosen as the example case for several different reasons. First of all, they are places less explored in the literature than similar communal public spaces such as museums, libraries, or conferences. Secondly, one outdoor market was in close proximity to the researcher's home location, providing a convenient testing ground. Finally, the researcher has prior experience in investigating outdoor markets as part of other research projects, providing a familiar starting point for the work (Nugent and Lueg 2010).

The decision to focus on current activities at the outdoor markets was made in response to a lack of understanding in the literature of how mobile technology was currently being used in these places. There is no purpose behind introducing a technological artefact if it does not facilitate the actions people at these places wish to perform, other than to investigate the usability of the artefact (which itself may be better performed under laboratory conditions (Kjeldskov et al. 2004, Kjeldskov and Skov 2014)). Ad-

ditionally there are other fields of research devoted to trying to build the future. This work prefers to gain an understanding of the present.

Lastly, the nature of outdoor markets makes immobile technology either too impractical or too expensive to implement on any scale to affect the market. Notable exceptions to this are public displays, audio systems, and cash registers which have been used by stallholders or researched in environments similar to markets. Mobile technology, on the other hand, is already extensively used worldwide and has been used in spaces similar to markets. With the research objectives scoped to something feasible, the rest of the work could begin.

7.1.2 Research Progression

Based on an analysis of the myriad options available to help structure the research presented in Chapter 3, the researcher selected the Participatory-Action-Design-Research (PADR) approach from the field of Urban Informatics. PADR was the selected because it matched well against the goals of this work. PADR takes the approach that a space must be understood before attempting any technological intervention for the space. When an intervention is to be introducing, this introduction follows an iterative approach where the intervention is improved over time using feedback from those people using it. Finally, PADR encourages results to take the form of both practical and theoretical findings.

Following the PADR approach, the research methodology was broken up into two distinct phases:

- *Phase One:* The first phase (presented in Chapter 4) was an exploratory phase attempting to better understand communal public spaces and the role mobile technology currently plays within them using the

People-Place-Information trichotomy (PPI) to structure the investigation. The phase was broken up into two stages: a broad survey followed by a semi-structured interview. From this phase it was discovered that there are three distinct uses of mobile technology in outdoor markets:

  - Information seeking.
  - Establishing and maintaining contact.
  - Documenting and sharing the experience.

  Only one of these, documenting and sharing the experience, was seen as working well.

- *Phase Two:* The second phase (presented in Chapter 5) was an experimental phase evaluating potential solutions to one of the identified issues from Phase One: the issue of keeping in contact with people while at the market. This phase began with a small exploratory component following up on an observation not fully realised from the earlier phase. Using semi-structured interviews to confirm the importance of mobile devices to people at the market, the researcher decided to use three pillars to guide the experimental development: people, space, and device. The experimental component used an iteratively evolving mobile application based on both the earlier work from Phase One and on new feedback of the participants. Data was collected through a group semi-structured interview and analysed via live audio-analysis.

Based upon the results of these two phases a new PPI-based framework was created, the People-Space-Device (PSD) framework, to aid future researchers in exploring communal public spaces and to help developers in

creating systems for communal public spaces. The PSD is a modification of the PPI with a heavier focus on both the device in use and on the *what* it is being used for and *how* it is being used while in communal public spaces.

7.1.3 Chapter Structure

The remainder of the chapter is structured as follows:

- Section 7.2 presents the contributions of the work as a whole based on the earlier chapters of this document.
- Section 7.3 reflects upon the limitations of, and challenges faced by, the work.
- Section 7.4 considers directions available for future work.
- Section 7.5 concludes the chapter and the dissertation as a whole and presents parting thoughts.

7.2 Contributions and Implications

This section summarises the contributions made by this thesis. First the contributions are stated and then each is discussed. The contributions are broken up into three categories: *substantive*, *theoretical*, and *methodological*.

The contributions from Phase One, the exploratory study and previously discussed in Chapter 4, are as follows:

- *substantive:* An analysis has been conducted of an outdoor market, the Salamanca Markets, from the perspective of the market as an Information Ground through the application of the People-Place-Information trichotomy. The trichotomy was used as the basis of a survey, from

which a picture of the Salamanca Markets as an information ground was created.

- *substantive:* The identification of the most common technology being used by people at outdoor markets has been discovered: smartphones, tablets, and occasionally cameras.

- *substantive and theoretical:* An identification of the common uses of the mobile technology while at the market has been found: information seeking and navigation; establishing and maintaining contact; and photographing, documenting, and sharing the experience.

- *substantive:* The creation of four personas based on the market participants has been completed: a market regular, a tourist, a reluctant attendee, and a stallholder.

The contributions from Phase Two, the experimental study (previously discussed in Chapter 5) are as follows:

- *substantive and theoretical:* The importance of mobile devices to the outdoor market experience has been discovered.

- *substantive and methodological:* The design and implementation of an iteratively-developed mobile software prototype has been completed. The prototype allowed participants to better keep in contact with one another and the design was based on a compass metaphor.

- *substantive:* The evaluation of the prototype systems has been performed, revealing the basic concept of the prototype to be sound.

- *methodological:* A novel technique for use in data analysis of audio interviews, live audio coding, has been attempted and shown to be feasible.

The contribution presented in Chapter 6, which collected and discussed the findings given in Chapters 2, 4 and 5, is as follows:

- *theoretical:* The successful creation of the People-Space-Device framework, a framework designed for developers and computing researcher for communal public spaces, through derivation from the People-Place-Information trichotomy from information grounds research.

7.2.1 Implications of Substantive Contributions

The substantive contributions of this work combine to achieve the research objectives by reporting on mobile technological use in communal public spaces: the most common devices, the activities, and the strengths and weaknesses of the devices and existing systems to support people's behaviours while at communal public spaces. The data collected supported the changes to the modified framework to better support computing researchers and developers, and provided the basis for the development, exploration, and evaluation of the prototype systems.

7.2.2 Implications of Theoretical Contributions

The theoretical contributions of this work meet the research objectives by providing an understanding of the most common issues faced when using mobile devices in communal public spaces and the importance of the mobile device to the experience of participating in a communal public space. The theoretical contribution also provided the impetus for the modification of a framework to explain communal public spaces.

7.2.3 Implications of Methodological Contributions

The methodological contributions of this work aid the realisation of the research objectives by reporting on the design, implementation, evaluation, and evolution of a mobile software prototype that addresses one of the main points of frustration identified by participants as well as with the creation of a new technique to rapidly analyse data. The review of the exploration and evaluation provides guidance to future researchers and systems developers on the design and evaluation of future systems supporting communal public spaces. The new data analysis technique allows for the faster processing of data into useable information.

7.3 Limitations and Challenges

Any research is going to be constrained in some manner and this limitation will impact the work to some degree. This section discusses the limitations of this work and the implications these limitations have on the findings. The limitation of this work are the scope, the technology, the participants, and the self-reported data.

Scope

This work was focussed on outdoor markets as the example case of communal public spaces. Outdoor markets were selected because of their large participant base, busy environments, similarity to many other already heavily researched areas, and because of the researcher's prior experience with them. The work also intentionally chose to focus on mobile technology due to the abundance of it in outdoor markets and, again, to the researcher's prior experience. Future studies should consider other spaces and other

technology mixes, such as public displays and mobile devices in airports.

Technology

During the experimental phase the prototype systems were created for Apple's iOS smartphone platform. This platform was chosen due to its popularity and the researcher's prior experience with the platform. Future studies should use multiple platforms or investigate what impact, if any, the different mobile platforms have on the participants.

Participants

The participants came from a variety of different backgrounds but all were attending an outdoor market. Additionally the only participants who took part in this research were those who were willing to do so, entire groups of market attendees may have been missed due to their unwillingness to participate. As such the findings may not be generalisable to people who are not market-people. The researcher however feels confident the findings and approach taken will be generalisable to people operating in places similar to an outdoor market. Future studies should endeavour to use more techniques which do not require participation to be effective, using traditional ethnographic tools such as long-term observation would be a good starting point.

Self-reported Data

At every stage of this work, the data collected relied *very heavily* on the participants' self-reporting. While every effort was made to ensure that the data was accurate to the real world, it is a known issue of self-reported data that it can be of lower precision and reliability than objective data collection methods. It was felt that this risk was a worthwhile one to take—not

only because of the difficulty in collecting the range of information that this work has, but also to this being a well known risk of this style of research (Lazar, Feng and Hochheiser 2010). Future studies should endeavour to use multiple methods of data collection, allowing for more objective data to go hand in hand with the subjective.

7.4 Future work

This study was intentionally non-longitudinal in nature; a longitudinal study of outdoor markets would not fit within the timelines of a doctoral candidature. A longitudinal study would be beneficial investigating the impact of repeated use of a prototype system and giving additional time for new iterations and evolutions on the idea would provide useful information about both the prototype and the habits of mobile device use at markets. This also would provide information on the change in habits, if any, of market regulars' use of mobile devices at outdoor markets.

In Chapter 5 the decision to focus on the frustration of keeping in contact with people while at the market was reported. This has the consequence of effectively ignoring the other issues identified earlier: establishing contact with people at the market, information seeking while at the market, and navigating while at the market. Future work should investigate these other issues in greater detail, in particular the issues around establishing new contacts at the market. Currently this role is served solely by applications with a dating focus and it is unlikely that everyone at a market wanting social interaction wants a romantic or sexual encounter as well.

The researcher chose to the use the People-Place-Information trichotomy from information grounds research rather than use the Socio-Physically

Informed Development Process from ubiquitous computing for a variety of reasons (as discussed in Chapter 2). The trichotomy, in the end, was found to be insufficient but was used as the basis for the creation of the People-Space-Device framework. The applicability of the Socio-Physically Informed Development Process, however, is still relatively unexplored. Future work should investigate how the Socio-Physically Informed Development Process fares in outdoor markets and can be compared to the People-Space-Device framework.

The People-Space-Device framework is an important contribution to the work, however, this is to date the only work to make use of it, as such additional research using the PSD needs to be performed. Future work using the PDS should be done with an aim to both improve and to validate the framework beyond what this research was able to perform.

This work was scoped to investigate only what role mobile devices played in outdoor markets. Future work should investigate what role other technology has in outdoor markets and what strengths and weaknesses exist around them. Of particular interest would be to see what effect combining multiple forms of technology has on a communal public space, such as public screens and mobile devices, or desktop and mobile devices working in conjunction.

Finally, similar to the scope of mobile devices, this work focussed solely on outdoor markets as the example case of communal public spaces. There are *many* more places which are communal public spaces: museums, libraries, airports, amusement parks, and stadia all come to mind as places with varying degrees of potential for exploration and understanding of the the interplay and breakdown of the People, Space, and Device properties within. Future work should explore some, or ideally all, of these other communal public spaces to see whether the findings of this work hold true

when applied to a different place than outdoor markets.

7.5 Conclusion and Parting Thoughts

At the start of this document it was stated that *there is an insufficient understanding into how technology can support communal public spaces.* In addressing this gap this research has set forth significant contributions on the substantive, methodological, and theoretical level. Previous studies into communal public spaces either have studied the space and offered no understanding into what part technology plays or have primarily focussed on the technological, creating a system and evaluating this system.

This work has explored the part which technology plays in communal public spaces through the lens of mobile devices in outdoor markets. In doing so, this work offers a number of contributions upon which future developers and researchers can build to better support these spaces. The dream of ubiquitous computing is that one day technology will be woven into the fabric of our lives without also disrupting them. By understanding and building better systems for communal public spaces we may not change the world but we will make it a better place to be.

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A

Phase One: Experimental Materials

This appendix provides the experimental material from the first phase of the research. The phase was reported on in Chapter 4. Formal ethics approval to perform the survey and semi-structured was granted by the Tasmanian Human Research Ethics Committee under approval numbers **H0013607** for the survey and **H0014178** for the semi-structured interviews.

A.1 Survey

The following provided material relates to the survey conducted as part of Phase One:

- Information sheet
- Formal ethics approval

A.1.1 Consent form

In the case of the survey, as formally approved by Tasmanian Human Research Ethics Committee (see Appendix A.1.3), participating and completing the survey was sufficient to satisfy informed consent. As such no consent form was necessary for the survey.

A.1.2 Information sheet

The information sheet for the survey is available at:
`http://tinyurl.com/H0013607-Approval`.

A.1.3 Formal ethics approval

The formal ethics approval for the survey is available at:
`http://tinyurl.com/H0013607-Information-sheet`.

A.2 Semi-structured Interviews

The following provided material relates to the semi-structured interview conducted as part of Phase One:

- Consent form
- Information sheet
- Formal ethics approval
- Interview topics

A.2.1 Consent form

The consent form for the semi-structured interview is available at:
`http://tinyurl.com/H0014178-Consent`.

A.2.2 Information sheet

The information sheet for the semi-structured interview is available at:
`http://tinyurl.com/H0014187-Information-sheet`.

A.2.3 Formal ethics approval

The formal ethics approval for the semi-structured interview is available at:
`http://tinyurl.com/H0014178-Approval`.

A.2.4 Interview topics

The following is the list of topics used to help guide the semi-structured interviews performed as part of Phase One. As previously discussed the semi-structured nature of the interview means these topics were open to change depending on the nature of the conversation with the participants.

- Reason for attending the market
- Local or visitor?
- Who they attended with
- People interacted with while at the market
- Phone use at the market
- Use of other technology

B

Phase Two: Experimental Materials

This appendix provides the experimental material from the second phase of the research. The phase was reported on in Chapter 5. The prototype that was part of the experiment is included in Appendix C. Formal ethics approval to perform the experiment was granted by the Tasmanian Human Research Ethics Committee under approval number **H0014765**.

B.1 Semi-structured Interviews

The following provided material relates to the semi-structured interview conducted as part of Phase Two:

- Consent form
- Information sheet
- Formal ethics approval
- Interview topics

B.1.1 Consent form

The consent form for the Phase Two prototype evaluation is available at: `http://tinyurl.com/H0014765-Consent`.

B.1.2 Information sheet

The information sheet for Phase Two is available at:
`http://tinyurl.com/H0014765-Information-sheet`.

B.1.3 Formal ethics approval

The formal ethics approval for Phase Two is available at:
`http://tinyurl.com/H0014765-Approval`.

B.1.4 Interview topics

The following is the list of topics used to help guide the semi-structured interviews performed as part of Phase Two. As previously discussed the semi-structured nature of the interview means these topics were open to change depending on the nature of the conversation with the participants.

- Use of the prototype
- Impact of the prototype on the market experience
- Issues with the prototype
- Other technology use while at the market
- Normal market attendance and activities

C

Phase Two: Prototype Materials

This appendix provides the technical materials from the prototype developed as part of this research. The prototype was reported on in Chapters 5 and 6.

C.1 Source code

The source code for the prototype system and instructions on how to use it are available at:
`https://github.com/McJones/PhD-Prototype`.